# SCIENCE

JULY 14, 1950

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PRECIPITATION FROM CUMULUS CLOUDS BY SEEDING TECHNIQUES

IRVING LANGMUIR

TECHNICAL PAPERS

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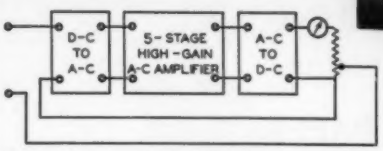


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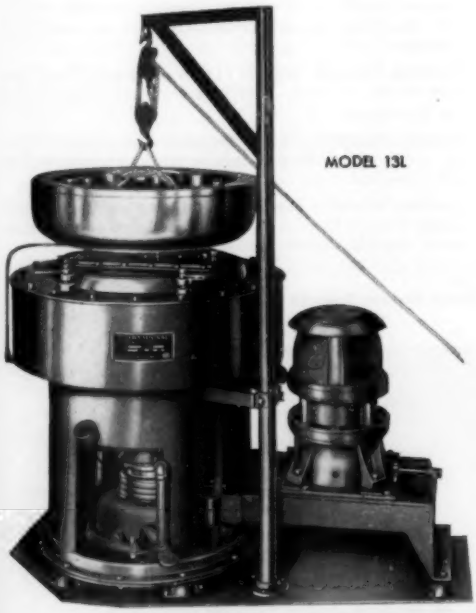

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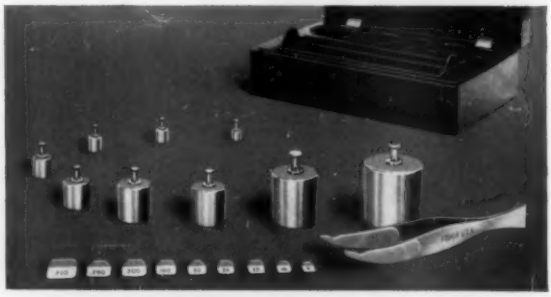

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## Table of Contents


Control of Precipitation from Cumulus Clouds by Various Seeding Techniques: *Irving Langmuir* 35

### Technical Papers

The Electron Microscopy of Sectioned Nerve: *George Rozsa* et al. 42

Studies on Pituitary Adrenocorticotropin: *J. B. Lesh* et al. 43

Sanitary Seal for Infrared Microcells: *Mortimer M. Elkind* 46

Electromagnetic Enrichment of $Fe^{58}$ Content and Concurrent Impoverishment of $Fe^{54}$ Content in Iron: *C. P. Keim, H. W. Savage,* and *Boyd Weaver* 47

The Eosinophil Response: Immediate vs. Delayed Eosinopenia: *Jules H. Last* et al. 47

Centrifugation as an Aid in Examining and Fixing Rotifers: *W. T. Edmondson* 49

A Comparison of Meteor Activity with Occurrence of Sporadic E Reflections: *V. C. Pineo* 50

Polymers from Chicle: *W. Schlesinger* and *H. M. Leeper* 51

Several Effects of Maleic Hydrazide on Plants: *Rufus H. Moore* 52

A New Microculture Slide: *Richard N. Shoemaker* 53

Absorption and Translocation of Radioactive 2,4-DI by Bean Plants as Affected by Cosolvents and Surface Agents: *John W. Mitchell* and *Paul J. Linder* 54

Effect of Bacterial Polysaccharide on Cell Division: *L. V. Heilbrunn* and *W. L. Wilson* 56

Amino Acids in High and Low Protein Corn: *R. C. Miller, L. W. Aurand,* and *W. R. Flach* 57

### Comments and Communications

Role of the Earth Sciences in General Education: *David M. Delo* 59

Compounds Capable of Plant Amylase Inhibition: *J. F. Volker* 61

Discovery of Early Cretaceous Mammals and Frogs in Texas: *Rainer Zangerl* and *Robert H. Denison* 61

Arctic Ice Drift and the Humboldt Current: *Floyd M. Soule* 61

Reaction Time of the Common Housefly: *Carl M. Herget* 62

I. Q. and Month of Birth: *Hans C. Gordon* and *Benjamin J. Novak* 62

### Book Reviews

Adaptation and Origin in the Plant World: Frederic E. Clements, Emmett V. Martin, and Frances L. Long. Reviewed by *John R. Reeder* 64

Phenomena, Atoms and Molecules: Irving Langmuir. Reviewed by *Karl Lark-Horovitz* 64

The Sea and Its Mysteries: John S. Colman. Reviewed by *Francis P. Shepard* 65

Plant Pathology: Sir Edwin J. Butler and S. G. Jones. Reviewed by *Clyde M. Christensen* 65

### Scientific Book Register 66

### News and Notes 67



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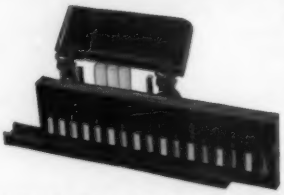

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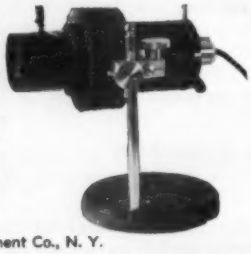

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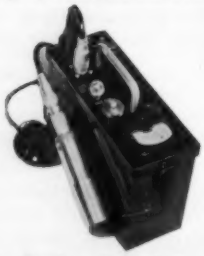

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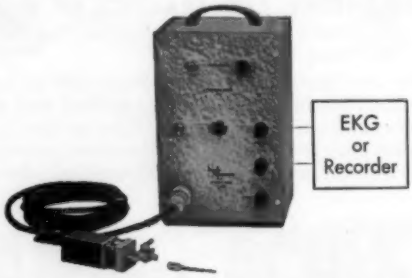


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# Control of Precipitation from Cumulus Clouds by Various Seeding Techniques[1]

Irving Langmuir
*General Electric Research Laboratory, Schenectady, New York*

CUMULUS CLOUDS are formed when moist air is heated by the sun's rays shining on underlying land. As the warmed air rises it cools, until finally at a certain altitude the moisture condenses at the cloud base, forming small cloud droplets. By this condensation of moisture, a great deal of heat is generated, which may overcome locally the natural stability of the atmosphere. The formation of the cloud, therefore, increases still more the tendency of the air to rise, so that once started, the cloud continues to rise and even accelerate until stopped by an overlying layer of very stable air.

When the cloud reaches the freezing level, the water drops in the cloud ordinarily do not freeze. The cloud is then said to be supercooled. The particles in the supercooled cloud turn to ice only if there are minute particles of ice or certain other foreign particles called *sublimation nuclei*. Sometimes these particles are already present but they may be introduced artificially by the seeding techniques described by V. J. Schaefer (*2*) and B. Vonnegut (*3*).

If no nuclei are present, or if there are too few, the cloud may rise to very great heights, where the temperatures are far below freezing, without many snow crystals forming. Such clouds ordinarily give no rain. The cloud may rise with increasing velocity to a height of 25,000 feet or 35,000 feet, and its inertia may carry it up to and even through a layer of stable air (temperature inversion) so that it becomes colder than the surrounding air. It then slumps back to a lower level, and some of the moisture that has previously condensed evaporates again. Under such conditions, no rain is produced.

If, however, the cloud rises so high that the temperature gets down to $-39°$ C, as it usually does at about 33,000 feet altitude, ice crystals of very minute size are formed in great numbers and almost instantaneously. The number of such particles may amount to $10^{12}$ per cubic inch. These come into contact with the supercooled water droplets and immediately cause them to freeze. This liberates a large amount of heat simultaneously over the whole top of the cloud, which rises still further. The top of the cloud thus forms a huge vortex ring which may be called a "ring crown." This is an irreversible process. If for any reason the cloud descends again, it will never go as low as if the ice crystals had not been formed. The heat generated usually makes the top of the cloud float away from the lower part, as a circular cirrus cloud of ice crystals. In its early stages it has the shape of a mushroom, or it may look more like a pancake.

The ice crystals then have the same size as the original water drops. They do not fall out of the cloud any more easily than do the water droplets of an ordinary supercooled cloud at high altitude. The pancake grows and gets thinner, usually increasing in diameter at the rate of about 25 miles an hour. At these very high altitudes, the wind is sometimes in a different direction from that near the lower part of the cloud, and so the pancake gradually drifts off to one side.

The ordinary anvil top of a thunderstorm in the North Temperate Zone of the United States is usually very unsymmetrical. We do not often see these circular pancake anvils that are characteristic of the tropics. I refer to them as "cirrus-pumping" pancake or mushroom clouds. One large cloud of this type may sometimes pump out cirrus clouds that spread over 10,000 square miles. Outside of the tropics, they may often occur during the summer in semiarid regions such as New Mexico or Arizona. Dr. Schaefer has observed them in Idaho during the summer. I have never seen a cloud of this type in the eastern part of the United States.

The characteristic thing about these convective clouds is that they form when the number of nuclei present in the atmosphere is so small that too few ice crystals develop in the cloud to use up any large fraction of the water in the supercooled droplets. Therefore, these few ice crystals that do form grow to relatively large size and fall out without setting up a chain reaction.

The large area of cirrus clouds usually formed by the cirrus-pumping mushroom provides shade for the underlying land and prevents it from heating so that no other cumulus clouds grow in the immediate neighborhood. Therefore, the conditions that lead to cirrus-pumping mushroom clouds make the production

[1] Based on a paper presented January 25, 1950 before the American Meteorological Society in New York City.

of rain from such clouds a very inefficient process. This is one of the main reasons that there is so little rain in Honduras and Costa Rica and other parts of Central America during the dry season. There is usually no lack of clouds over the higher mountains of these countries, but the clouds that do form often rise to 35,000 feet and even 40,000 feet and yet give no rain.

Then how *does* rain form from cumulus clouds? Nuclei must be present in order to get rain. The sublimation nuclei that occur in the atmosphere vary in concentration from about 1 particle per cubic meter of air to about $10^7$ particles per cubic meter. They vary tremendously at different times and places. Furthermore, the naturally occurring nuclei differ in regard to the temperature at which they become effective. Most naturally occurring sublimation nuclei are not effective unless the temperature is below about −20° C (0° F). That is, clouds that contain such nuclei will form ice crystals only when they reach high altitudes, such as 25,000 feet or 30,000 feet. In other cases, the nuclei may become effective at lower altitudes.

If the concentrations are low—about 100 or 1,000 per cubic meter—only one snow crystal forms in the supercooled cloud for each nucleus present. These grow rapidly in size and soon begin to fall so that in a cloud without high vertical velocities, the snowflakes fall out of the cloud as fast as the nuclei enter it, and the result is that nothing happens—just a trace of rain falls.

To get heavy rain, a chain reaction must occur, by which one snow crystal produces two, and two produce four, and four eight, etc., giving a runaway effect. This is like the spread of a contagious disease or like a fire spreading through a haystack. The chain reaction that leads to a thunderstorm or any very heavy storm usually starts by a fragmentation of the snowflakes. The snow crystals begin to collect into aggregates and then knock against one another and break into fragments which are carried back up into the cloud so that each in turn grows into a large snowflake.

The conditions that are necessary for the beginning of such a chain reaction are very critical. There has to be a certain minimum number of nuclei of a given type, and the process is greatly helped by turbulence within the cloud. The critical conditions occur at some one point in the cloud at a certain altitude and time rather than throughout the cloud as a whole. Thus, the cloud that develops is unsymmetrical and is entirely different in shape from the mushroom cloud of the tropics, where the whole top of the cloud suddenly goes over into ice crystals when it reaches the level corresponding to −39° C.

Where the chain reaction starts, there is a local evolution of heat. If this occurs first at a rather low altitude, then the warmer air produced by the freezing of the moisture rises and stirs up the whole cloud. If heat is generated near the ceiling of a closed room, the hot air stays there, but if it is introduced near the floor, it stirs up all the air in the room.

We can conclude that heavy natural rain from large supercooled cumulus clouds occurs only when both of two separate conditions are fulfilled. First, the weather conditions must be favorable; that is, the *synoptic situation* must be favorable. There must, for example, be sufficient moisture and wind to carry it to the place where the cloud is growing. Second, there must be a concentration of sublimation nuclei to generate sufficient heat within the cloud to overcome the stability of the atmosphere and cause the clouds to grow rapidly and produce turbulence. This turbulence is needed to set up the chain reaction essential for the occurrence of heavy, self-propagating rain showers.

## Artificial Seeding

In the early experiments in seeding cumulus clouds with dry ice, relatively large amounts of the dry ice were dropped at the top of the clouds. It was crushed to such sizes that there were many fragments about ½ inch or ¾ inch in diameter, which would fall through the entire cloud and reach the freezing level before evaporating. When this is done, enormous numbers of minute ice crystals or sublimation nuclei consisting of ice are produced at all levels within the cloud. Overseeding frequently occurs, so many nuclei being produced that the snowflakes that form may even outnumber the original water drops, and they tend not to fall out of the cloud. The heat generated makes the top of the cloud float off, separating itself from the lower part. Thus the cloud is often dissipated without producing rain.

The use of a single pellet of dry ice, about a ¾-inch or 1-inch cube, may have distinct advantages for seeding. Although the falling pellet produces a high concentration of nuclei along its path, the cloud as a whole will have parts that are underseeded. Under these conditions, large snowflakes will form at all altitudes above the freezing level, and this is more apt to produce self-propagating storms and may lead to heavy rain. The best results are obtained by putting the pellet into the cloud at the right place and at a time when the cloud is ripe or has grown to a condition capable of sustaining a continuing chain reaction.

Often, heavy rain may best be obtained from a large cumulus cloud by using a single pellet of dry ice shot into the side of a cloud from a Very pistol.

For this purpose, the plane does not need to enter the cloud but can fly near its outer surface and the pellet can be shot to a horizontal distance of 700 feet or more into the cloud. If this is done at a height of 1,000 or 2,000 feet above the freezing level, the heat generated by the freezing of the supercooled water droplets is generated only in the lower part of the cloud, greatly increasing the turbulence and favoring the start of a chain reaction.

The best way to dissipate large cumulus clouds or to stop their growth is to introduce high concentrations of ice nuclei near the top of the growing cloud. This localized overseeding of the top can be accomplished conveniently by the use of a device called a "Trickler," which lets liquid carbon dioxide escape, only a few grams per second, through a hole 0.003 inch in diameter.

Enormous numbers of ice nuclei are produced along the line of seeding, but the minute snow crystals that form do not fall into the lower part of the cloud. The upper part of the cloud thus lifts off from the lower part, and the ice crystals do not get into the part of the cloud where they could cause turbulence and set up a chain reaction. It is also possible to use very finely pulverized dry ice that falls only a few hundred feet before evaporating. Or a single large piece of dry ice can be towed in a net behind the plane.

Artificial seeding has many advantages. By properly choosing the point of seeding, effects can be produced that do not occur naturally. Under natural conditions, the probability of rain varies, depending upon the number and type of natural sublimation nuclei. In the tropics the number of nuclei is low during the dry season. Spontaneous seeding of the clouds then occurs only at very high altitudes and ice forms spontaneously only at the $-39°$ C isotherm. Further north, it is more common to have nuclei that are effective at higher temperatures, and these may be present in larger numbers so that clouds frequently tend to seed themselves at low altitudes.

The cirrus-pumping mushroom clouds of semiarid regions ordinarily give no rain or are very slow in starting to produce rain. When nuclei, such as those from dry ice or silver iodide, are introduced into these clouds at elevations only a little above the freezing level, the cloud is completely modified within 10 or 15 minutes. Ice crystals are formed at low altitudes and grow rapidly to such size and number that they start the chain reaction long before the cloud reaches the $-39°$ C level, and thus the cloud becomes an efficient rain producer.

The pancake top can be prevented from forming if the cloud is seeded when it reaches altitudes where the temperatures are only $-10°$ C or $-20°$ C. One or two pellets of dry ice introduced just above the freezing level are enough to transform a cloud into an efficient rain producer. Many of the ice crystals that are formed by seeding at low altitudes remain in the cloud and are carried up into any anvil top that may develop. Later they fall out and snow is thus entrained into the lower parts of neighboring cumulus clouds, preventing widespread overcast, so that nearly all the moisture in the cloud comes to the ground in the form of rain. With the circulation set up by a chain reaction, such clouds may continue to give rain for many hours.

Silver iodide smoke introduced below the cloud base, either on the ground or by a plane flying below the cloud, is an exceptionally easy and advantageous way to increase the rainfall in those areas where cirrus-pumping clouds would normally prevent rainfall. Seeding of this kind may modify the synoptic situation over wide areas.

The control of a system of cumulus clouds requires knowledge, skill, and experience. Failure to consider the importance of the type of seeding, the place, and the time, and also the failure to select the best available clouds, explain why the Cloud Physics Project of the U. S. Weather Bureau was not able to obtain "rainfall of economic importance."

## Seeding Experiments in New Mexico

For many years, I have been developing philosophical ideas in regard to cause and effect relationships in science (*1*). The causality that used to be characteristic of classical physics applies strictly only to *convergent phenomena*, which depend upon a large number of separate events whose effects converge to give a well-defined average. There are, however, in atomic physics, as well as in human affairs and meteorological phenomena, what we may call *divergent phenomena*, where large important events grow from small beginnings that produce diverging results. Shower formations such as those in arid regions like New Mexico are good examples of divergent phenomena.

On this basis, the synoptic situation and the concentration of sublimation nuclei are important only insofar as they determine the *probability* that a shower will occur. Neither factor alone is the direct cause of the shower that occurs at a definite place or time.

To get a heavy shower or thunderstorm requires, as we have seen, the presence of natural or artificial nuclei, in sufficient numbers to convert a portion of the supercooled cloud into ice crystals, thereby generating heat sufficient to overcome the stability of the atmosphere and set up a chain reaction in the production of new snow crystals.

According to the Boltzmann equation, the number of molecules per second that evaporate from a given heated surface of any known substance is given by

$$n/n_0 = e^{(-Q/KT)} \quad (1)$$

where $n_0$ is a constant, $Q$ is the heat of evaporation per molecule or the energy per molecule that must be overcome in the escape of the molecule from the surface forces, and $KT$ measures the average kinetic energy of the molecules.

By analogy, we may assume that the probability of the start of a shower in a given area and time interval varies in a similar way with the ratio of two energies: that needed to overcome the atmospheric stability and that available by the conversion of supercooled water droplets into ice crystals. In a semiarid country like New Mexico we may take the average rainfall, $R$, in a 24-hour period over a given area, as a measure of the probability of shower formation. We are thus led to the equation:

$$R/R_0 = e^{(-C_1/C)} \quad (2)$$

where $R_0$ is the maximum average rain over the area that could be produced by the optimum concentration of nuclei, $C$ is the actual concentration of nuclei, and $C_1$ is the concentration that would be needed to make $R/R_0 = 1/e = 0.37$. The quantity $C_1$ is determined by the synoptic situation, which is presumably determinable from data given on weather maps with additional data involving local conditions such as orographic effects. Thus, the probable rain depends on the ratio between two factors $C_1/C$, where the first factor is a measure of the synoptic situation and the second factor is the concentration of sublimation nuclei, natural and artificial.

Equation (2) can also be written

$$C/C_1 = 1/\ln(R_0/R). \quad (3)$$

Thus from observed rainfall data, we can calculate $C/C_1$.

If sublimation nuclei are generated at a point on the ground or in the air, then in presence of vertical convection that distributes the nuclei, the concentration of the artificial nuclei will vary inversely as the distance $D$ from the source at distances beyond that required for uniform vertical mixing. Thus the quantity $C/C_1$ found from the observation will vary linearly with the reciprocal of the distance $D$, so that in general if $C_1$ is reasonably constant

$$C/C_1 = C_0 + E/D \quad (4)$$

where $C_0$ is a measure of the natural nuclei already present in the atmosphere and $E$ is a constant under given conditions.

We have used this probability theory to analyze the data obtained in seeding experiments conducted by Project Cirrus, for the U. S. Army Signal Corps and the U. S. Navy near Albuquerque, New Mexico. In the first test chosen for analysis, conducted on October 14, 1948, it was found that about 0.35 inch of rain was produced over an area of at least 4,000 square miles. This corresponds to 100,000,000 tons of rain. Later calculations showed that the total rain area corresponded to a rainfall of about 800,000,000 tons, or roughly 200 billion gallons of water.

Four seedings were carried out that day. The first one, in the morning, was done by Dr. Vonnegut's method with about two ounces of silver iodide dispersed by dropping impregnated burning charcoal pellets from an airplane at 12,000 feet. The other three seedings involved amounts of dry ice from 15 to 25 pounds. Very striking results were produced by the dry ice; there were two thunderstorms, which were photographed for about an hour and a half.

More widespread effects were produced by the operation of a silver iodide generator on the ground in the later tests, held during July 1949. The first seeding with silver iodide in this experiment was on July 15, 1949, but the generator was not run for more than a couple of hours on any day thereafter until the 19th, when it was operated for a short time only, late in the afternoon. On July 20, it was not operated at all, but on the 21st it was operated for 13 hours, starting about 5:30 a.m., and a total of 300 grams of silver iodide was used. Tests made by Dr. Vonnegut have shown that each gram of silver iodide dispersed under these conditions produces $10^{16}$ sublimation nuclei that are slowly effective at $-5°$ C but very rapidly effective at $-10°$ C.

We chose for analysis the data obtained on two days, October 14, 1948, and July 21, 1949. These days were chosen because large amounts of silver iodide were used, but no seeding was done on the immediately preceding days. Furthermore, the wind direction on both days was rather similar. On both days, the Weather Bureau predicted no substantial amounts of rain. Both mornings were nearly cloudless, and on both days southwest winds prevailed from the cloud bases at 12,000 feet up to 20,000 feet. At lower and higher altitudes and later in the day, there were also winds from the east, west, and northwest. On both days, visual effects indicating thunderstorms and heavy rain over wide areas were observed a few hours after the start of the seeding operations.

In the July operation, our techniques had been much improved over those of the preceding October. On October 14, radar observations covered only a period of about an hour in the afternoon, for at that time it was not suspected that the rain that lasted well on to the morning of the 15th had any relation to the seeding.

On July 21, 1949, however, we had complete radar

coverage from early in the morning until late at night. Photographs of the clouds were taken not only from planes but from the ground, and they included lapsed time motion pictures with frames every few seconds.

Shortly before 8:30 a.m. on July 21, 1949, a single large cumulus cloud began to form about 25 miles south of the field station near Albuquerque in a sky that was otherwise cloudless. This cloud was located near the Manzano Mountains, and the silver iodide smoke had been blowing from the north about 10 miles an hour, so that it should have reached the position of the cloud. Between 8:30 and 9:57, the cloud grew in height slowly at the uniform rate of 160 feet per minute. At 9:57, when the top of the cloud was at 26,000 feet (temperature −23° C) the upward velocity of the top of the cloud increased quite suddenly, so that the cloud rose 1,200 feet per minute until at 10:12 it had reached 44,000 feet (temperature −65° C). At 10:06, when the top of the cloud was 36,000 feet (temperature −49° C) the first radar echo return was obtained from the cloud at an altitude of 20,500 feet (temperature −9° C). The distance given by radar was 25 miles at an azimuth of 165°, which was exactly where the cloud was found to be from visual observations. The area of precipitation in the cloud was about 1 square mile at that time and deep within the mass of the cloud. Within 4 minutes, the precipitation area had increased to 7 square miles and within 6 minutes after the first echo appeared, the precipitation had extended upward to 34,000 feet, where the temperature was −43° C.

The chain reaction in this cloud started at low altitude, at a time and place that agreed well with the trajectory of the silver iodide smoke. The first flash of lightning was seen at 10:10, 4 minutes after the first radar echo was detected. In all, perhaps a dozen flashes of lightning formed from this cloud, and very heavy rain was seen to fall to the ground. The top of the cloud moved westward, but the lower part of the cloud from which the rain was falling moved gradually to the northeast.

At 10:47 a second cloud, about 8 miles still further to the northeast, developed a radar echo, and from that time on during the day the number of rainstorms increased, producing very heavy showers in the neighborhood. During the late afternoon, 1.2 inches of rain fell at the station where the generator was located. There was exceptionally heavy rain at Santa Fe.

*River flow data.* On the morning of July 22, I had occasion to fly from Albuquerque to Los Alamos and on the way passed over Domingo on the Galisteo Creek near the place where it enters the Rio Grande River. This creek looked like a large river carrying perhaps a third as much water as the Rio Grande. I asked the pilot about this stream and he said that it was merely a dry wash and that never before had he seen any appreciable amount of water in it. Recently, I have obtained from the U. S. Geological Survey, through the kindness of Mr. S. E. Reynolds of the New Mexico School of Mines at Socorro, data on the flow in the Galisteo Creek for every day since June 1946 and similar data for the Pecos River at Santa Rosa. Within the 30-hour period after the river flow began on July 21 the flow in the Galisteo Creek amounted to 3,000,000 tons, or 0.65 billion gallons. The area of the watershed of the Galisteo River is about 500 square miles. The flow in the Pecos River amounted to 12,000,000 tons, or 3 billion gallons, and the area of the basin is 2,700 square miles.

It is of interest to note that the average flow rate of 3,900 cubic feet per second for the day of July 21, 1949, in the Pecos River was considerably higher than any day since June 1946. In the case of the Galisteo River there was only one day in that three-year period that gave slightly more rain than on July 21.

*Rain gauge data.* The Weather Bureau publishes climatological data for New Mexico monthly, about two months after the end of the month in which the data were recorded. About 300 stations well distributed over New Mexico give the total rainfall for each day and, of these, about 70 stations give hourly reports of rain. For the tests that Project Cirrus made in July 1949, the Weather Bureau also installed 24 additional recording rain gauges within the range of about 40 miles of Albuquerque. Several months have been spent in making a careful analysis of these rainfall data and even extending them into the states of Arizona, Colorado, Kansas, Oklahoma, and Texas.

The Weather Bureau observer with Project Cirrus in New Mexico stated that he considered it possible or even probable that seeding operations carried on there could have increased the naturally occurring rain by 5 percent, but certainly not more than 10 percent. If this were true, it would be possible to conclude that seeding operations had economic value only if experiments are carried on many hundreds of days, and a statistical analysis were made of the rainfall data for all of these operations. The data actually show, however, that the rainfall on both October 14, 1948, and July 21, 1949, was exceptionally high and could not possibly have been accounted for as the result of naturally occurring rain.

The map of the state of New Mexico, which represents about 120,000 square miles, was divided into eight octants or 45° sectors radiating out from Albuquerque. Then concentric circles having radii of 30, 75, 125, and 175 miles were drawn on the map. This divided the whole state into 27 regions whose average

distances and directions from Albuquerque were known. By entering on the map for each of these regions the average rainfall for October 14, 1948, and July 21, 1949, a comparison could be made of the distribution of the rain on those two days. An objective way of evaluating the similarity between such two distributions is to employ the statistical device known as the correlation coefficient, which was found in this case to be +0.78. The chance that such a high value would occur among these figures if one set of them were shuffled giving a random distribution is only 1 in $10^7$ or 1 in 10 million. Such close agreement in the distribution on two days could thus hardly be the result of chance. We believe that the close similarity in distribution is dependent not only on the rather uniform synoptic situations over the states that prevailed on these days but also on the fact that on both days the probability of rainfall depended on the nuclei that spread radially out from Albuquerque, the concentration decreasing as the distance from Albuquerque increased.

The next step was to analyze the characteristics of this distribution that are so similar on these two days. On each day nearly all of the rain occurred within four of the eight octants. Each sector was divided into 4 to 6 parts, arranged radially so that each would contain equal numbers of observing stations (about 8 per region). The average rainfall rose rapidly to a maximum in intensity about 30 miles from the point of seeding and in each of the 4 sectors it decreased regularly as the distance from the source of the silver iodide smoke increased. In fact, this decrease followed quite accurately equations (2) and (3), indicating that the rainfall depended on the concentration of nuclei, and this, in turn, varied inversely in proportion to the distance from the source. This analysis made it possible to separate the effects of the artificial silver iodide nuclei from that of the background of sublimation nuclei already present in the atmosphere. The results showed that $C_0 = 0$, so that there was no appreciable background on either of these two days. We must conclude that nearly all of the rainfall that occurred on October 14, 1948, and July 21, 1949, was the result of seeding.

The agreement between the intensity of the average rainfall in separate regions and the theoretical equations was so good in each of the four sectors on October 14 and July 21 that the probability factors for each sector ranged from $10^2$ to $10^3$, showing that the observed agreement was not accidental. Taking all the octants together, the probability factor rose to about $10^8$ to 1.

*Time of starting of the rain and its variation with the distance from the generator.* For each of the eight octants that showed appreciable rainfall, the rain started progressively later as the distance from the source of the silver iodide increased. The advancing edge of the rain area thus moved from Albuquerque on July 21 at a velocity of about 15 miles an hour and on October 25 at a speed of about 25 miles an hour. These velocities agree well with the wind velocities observed at various altitudes.

The method of the correlation coefficient can be applied to the relation of the time of the start of the rain to the distance from Albuquerque. This indicates that there is another probability factor, which is of the order of $10^8$ to 1.

Taking these results all together, it seems to me that they prove conclusively that silver iodide seeding produced practically all of the rain in the state of New Mexico on these two days. The results for the other days of the experiments, although somewhat more complicated, due to the overlapping of the effect of seeding on successive days, are almost as striking, and the probability factors are very high.

Dr. Vonnegut has measured the number of effective sublimation nuclei produced by the type of silver iodide smoke generator used in our New Mexico experiments for each gram of silver iodide used. On July 21, 1949, the 300 grams of silver iodide generated yielded $3 \times 10^{18}$ nuclei. The analysis of the rainfall data shows that a concentration of 1 milligram of silver iodide per cubic mile of air is enough, under the synoptic conditions that prevailed in New Mexico, to give a 1-in-3 chance that heavy rain will occur during any one day at any place. Assuming the atmosphere to be 5 miles thick, one thus finds that to get a 30 percent chance of rain per day within a given area in New Mexico, the cost of the silver iodide is only $1.00 for 4,000 square miles.

If similar conditions prevailed over the whole United States, the cost per day to double the rainfall would be only of the order of a couple of hundred dollars. This verified an estimate that I made in November 1947 in an address before the National Academy of Sciences that "a few pounds of silver iodide would be enough to nucleate all the air of the United States at one time, so that it would contain one particle per cubic inch, which is far more than the number of ice nuclei which occur normally under natural conditions." Such a distribution of silver iodide nuclei "in the atmosphere might perhaps have a profound effect upon the climate."

It is interesting to note that 30 milligrams (1/1,000 ounce) of silver iodide (cost 0.2 cents), when distributed in 30 cubic miles of air, liberate as much heat when it enters into the bases of large supercooled cumulus clouds 6 miles in diameter as the explosion of an atomic bomb. This is the heat freed when the supercooled cloud changes to ice crystals.

I have been developing a new theory of the rate of growth of snow crystals in supercooled clouds containing known numbers of sublimation nuclei. It turns out that the initial growth occurs in accord with a diffusion theory proposed many years ago. But when the snow crystals grow to a size of a few tenths of a millimeter, and especially when the air is turbulent, the crystals grow 10 to 50 times faster than the rate given by the older theory. This is in accord with observations of the extraordinary speed with which some cumulus clouds turn into active thunderstorms, such as the cloud of July 21, 1949, and another cloud on October 14, 1948. And the concentration of 1 milligram per cubic mile, which was found to be so effective in producing showers, is just the concentration that is needed to convert all supercooled water droplets into ice crystals within about 4 minutes.

From the probability theory of the growth of showers from artificial nucleation, one obtains the result that the total amount of rain produced by operating a ground generator increases in proportion to the square of the amount of silver iodide used. Thus, with 3 times as much iodide one would get 9 times the rainfall. The intensities of the showers would be no greater, but they would extend over a greater area.

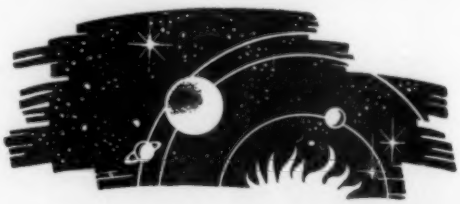
An analysis of the July 1949 rainfall in New Mexico, Arizona, Colorado, Oklahoma, Kansas, and Texas gives evidence that a band of heavy rain progressed in an easterly direction during the period of July 20 to July 23 from southern Colorado across the southern half of Kansas, where it gave 3 to 5 inches of rainfall in many places. It may have been dependent on the silver iodide nuclei generated near Albuquerque between July 18 and 21 and in central Arizona between July 19 and 21. Furthermore, the heavy rains that spread throughout New Mexico from July 9 to 13, before the start of Project Cirrus seeding experiments, appear to have depended on silver iodide seeding in Arizona on July 5 and 6.

It is very important that regular tests be carried out on certain selected days of each week throughout the year, using amounts of seeding agents just sufficient to obtain conclusive statistical data as to their effectiveness in producing widespread rain. It is to be expected that the results will vary greatly in different parts of the country because of the changes in synoptic situations.

I believe the time is now ripe for beginning an intensive study of tropical hurricanes. It is highly probable that by using silver iodide generators at sea level in the regions where large clouds first begin to grow into incipient hurricanes, the hurricanes can be modified and even prevented from reaching land.

**References**


1. Langmuir, Irving. *Science*, 1943, **97**, 1.
2. Schaefer, V. J. *Science*, 1946, **104**, 457.
3. Vonnegut, B. *J. appl. Phys.*, 1947, **18**, 593.

# Technical Papers

## The Electron Microscopy of Sectioned Nerve

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Nerve is one of the most important tissues for study under the electron microscope both because knowledge of its macromolecular structure is needed for an understanding of the mechanism of impulse propagation and because this knowledge is essential for any study of the neurotropic virus diseases. Until recently little progress in such a study has been possible on account of the large size and fragility of most nerve fibers. They can, however, now be examined to great advantage in thin section.

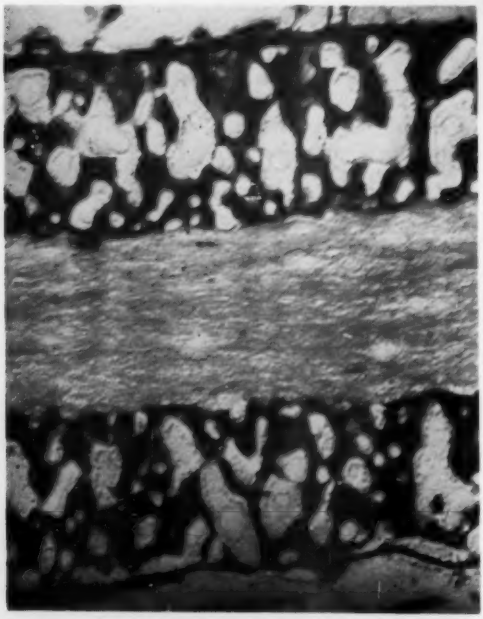

FIG. 1. An electron micrograph of a longitudinal section through a single fiber of myelinated nerve. The fibrous contents of the central axon are clearly seen, as are the denser lamellae of the surrounding myelin. The thin neurilemma enveloping the whole is visible at the very top and bottom of the photograph. Magnification, 5,000 ×.

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FIG. 2. A nearly transverse section through part of a nerve bundle. One fiber showing the same structures as Fig. 1 fills most of the picture. Small parts of two other fibers are in the lower right corner and the top, left of center. A band of connective tissue and the embedded sectioned tip of another fiber separate the lower fiber from the one in the center. Magnification, 5,000 ×.

Very recently preliminary electron micrographs have been published of sectioned nerve (*1*) but these photographs were of fibers that were so seriously damaged during preparation that their fine structures and the relation of these structures to one another were not evident. We have found that excellent sections can be obtained of nerve prepared and cut according to the techniques outlined by Newman, Borysko and Swerdlow (*2*). What is seen in such sections under the high resolution of the electron microscope depends in marked degree on the kind of fixation and dehydration used, and it will require much experimentation with many reagents to establish beyond doubt all aspects of the macromolecular texture of native nerve. Nevertheless, nerve can now be sectioned without disturbing its various components and consequently a detailed study can now be begun of its structure and of the changes caused by various preparative reagents.

Results of a first set of such experiments are being published elsewhere (*3*) but the accompanying photographs illustrate the kind of electron micrographs of sectioned nerve that can readily be prepared. These

show a longitudinal (Fig. 1) and nearly transverse (Fig. 2) section through the *nervus ischiadicus* of the adult rabbit fixed in 4% formalin and dehydrated in one case in ethyl alcohol and in the other with pyridine. In the longitudinal section one can see the filamentous fine structure of the central axon and the more "opaque" lamellar texture of the nonlipid portion of the enveloping myelin sheath. The neurilemma outside this and the absence of an axilemma of similar structure between axon and myelin are apparent. The same structures are visible in Fig. 2, which also gives an idea of the relation of a nerve fiber to the connective tissue elements with which it is associated in a complete nerve bundle. This photograph likewise brings out the fact that in many parts of nerve fibers the texture of the lamellae of the myelin is less coarse in the region immediately enveloping the axon. Other photographs we have made both at these and at higher magnifications show the fine details of the structures, the kinds of alteration in these details that result from the use of other fixatives, and the nature of such other optically recognized structures as the clefts of Schmidt-Lantermann and the nodes of Ranvier.


**References**

1. Fernández-Morán, H. *Exp. cell. Res.*, 1950, **1**, 143.
2. Newman, S. B., Borysko, E., and Swerdlow, M. *Science*, 1949, **110**, 66.
3. Kozba, G. *et al.* *Biochim. Biophys. Acta*, in press.


## Studies on Pituitary Adrenocorticotropin


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A considerable portion of the recent work on chemistry of the pituitary adrenocorticotropic hormone (ACTH) has indicated that it might have a relatively small molecular size. This is in contrast to earlier reports (*4*, *5*) of its protein nature and of the isolation of a "pure" protein having a molecular weight of approximately 20,000. Such possibilities are important in view of the limited supply of ACTH from animal sources, since synthesis of the hormone would provide a more adequate solution to the problem of supplying the clinical demand for the material.

Several preliminary reports on the preparation of active peptides from ACTH have appeared. The evidence provided in these preliminary reports does not definitely show that the activity observed is to be identified with a single peptide. Li (*5*) states that the *average* peptide size in a mixture of peptides following hydrolysis with pepsin of ACTH protein is eight amino acid residues.

Cortis-Jones *et al.* (*2*), employing ultrafiltration without partial hydrolysis, showed that biological activity will pass through cellophane membranes impermeable to molecules of 13,700 molecular weight but permeable to those of 8,000. Morris (*7*) indicated that the size of the ACTH molecule varies with pH and that this variation appeared to be a reversible phenomenon.

Brink *et al.* (*1*) reported the clinical activity of dialyzates following peptic hydrolysis.

Li (*6*), employing an acetic acid-butanol-water system on paper, separated six ninhydrin-positive spots, one of which was highly active in the adrenal ascorbic acid assay. Sedimentation and diffusion studies that were made on the peptide mixture led to an average molecular weight of 1200 for the peptide mixture that contained no free amino acids.

Some confusion is added to the picture by the use of ACTH from different species, but there is little evidence thus far to indicate major differences in the hormone from the pituitaries of the three species most widely used, namely, swine, sheep, and cattle.

TABLE 1

Fractionation of ACTH by Adjustment of pH in Aqueous Solution

| Preparation | Initial potency × La-I-A | Fraction insoluble at pH | Fraction soluble at pH | Yield % | Potency × La-I-A |
|---|---|---|---|---|---|
| 1 | 2.2 | 7.3 | | 7.1 | 8 |
| | | 6.3 | | 6.2 | 6 |
| | | 5.6 | | 5.2 | 10 |
| | | | 5.2 | 70 | 1 |
| 2 | 2 | 7.3 | | 5 | 8.6 |
| | | 6.2 | | 6 | 2.3 |
| | | 5.2 | | 5 | 11 |
| | | | 5.2 | 67.5 | 0.5 |
| 3 | 1.9 | 6.6 | | 10.8 | 10 |
| | | 6.0 | | 3.3 | 6 |
| | | 5.0 | | 5.4 | 6 |
| | | | 5.0 | 74 | 1.5 |
| 4 | 1.9 | 7.2 | | 10.5 | 4 |
| | | 6.2 | | 6 | 7 |
| | | 5.2 | | 6 | 7 |
| | | | 5.2 | 75 | 1.5 |
| 5 | 4 | 7.6 | | 5.7 | 22 |
| | | 6.3 | | 3.5 | 21 |
| | | 5.3 | | 4.1 | 11 |
| | | | 5.3 | 75 | 1.6 |

Our studies on the properties of ACTH carried on over the past two years have been confined largely to that from pork pituitaries, which provide the best yield and upon which clinical experience is based. Although we have been able to concentrate the hormone and have obtained fractions with potencies of the order of 100–150 times standard or 100–150 times that of the previous reported pure ACTH proteins, these fractions appear to have molecular weights of from 2,500 to 10,000 rather than 1,000 or less. The general methods of preparation and characteristics of these fractions are described.

As starting material for preparation of more potent fractions, ACTH prepared for clinical use was employed. These preparations were obtained from fresh, frozen, whole hog pituitary glands by acid-acetone extraction followed by phosphate partition and ammonium sulfate

TABLE 2

RECOVERY OF BIOLOGICAL ACTIVITY OF ACTH FOLLOWING PEPTIC HYDROLYSIS AND TRICHLORACETIC ACID PRECIPITATION

| Preparation | Initial Potency × La-I-A | Potency after treatment | | Activity recovered in $CCl_3COOH$-soluble fraction |
|---|---|---|---|---|
| | | $CCl_3COOH$-soluble × La-I-A | $CCl_3COOH$-insoluble × La-I-A | |
| | | | | % |
| A | 2.5 | 4 | 1.5 | 43 |
| B | 2.5 | 7.5 | 2.4 | 82 |
| C | 10 | 17 | 8 | 53 |
| D | 10 | 16 | 2.4 | 42 |
| E* | 6 | 8 | | 100 |
| F* | 3 | 6.4 | 0.8 | 45 |

* Second treatment with pepsin and trichloracetic acid of soluble (E) and insoluble (F) fractions.

precipitation with suitable modifications to reduce posterior pituitary contamination to the low level required for clinical use.

Assay of ACTH was that of Sayers, Sayers and Woodbury (*9*) as modified by Munson and was based upon the depletion of ascorbic acid in the adrenal glands of the hypophysectomized rat. Potencies are reported in terms of Lot La–I–A, an arbitrary standard. One microgram of this standard injected intravenously produces a 20%–30% decrease in adrenal ascorbic acid in the 28-day-old hypophysectomized rat. Representative fractions showing high biological activity by this method have been shown to have comparable potency clinically.

*pH effects.* Increased potency of ACTH is readily obtained by fractional precipitation of the starting material in aqueous solution by pH adjustment. The removal of insoluble protein at pH 7, 6, and 5 from a 0.5% suspension of starting material in water yields 20% of the preparation showing 3–4 times initial potency. Further adjustment of pH toward higher acidity does not cause precipitation at the concentration employed. Examples of this procedure are shown in Table 1. Study of concentrates from the supernatant fluid shows no indication that a low molecular weight biologically active material is to be found in that fraction.

*Peptic hydrolysis.* These fractions were then treated with crystallized pepsin to increase further the potency of the materials. A 2% solution of the fraction was treated with 3.7 mg/g of crystallized pepsin for 2 hr at 38° C and pH 2.5. Hydrolysis was stopped by heating the solution to 95° C for 15 min. The protein was then precipitated by addition of trichloracetic acid to 5% and the supernatant fluid was freed of trichloracetic acid by repeated washing with ether. After removal of the ether the supernatant fluid was dried. Approximately twofold increase in potency was obtained by this procedure, as shown in Table 2. Data showing that retreatment of active fractions with pepsin has little or no effect upon the biological activity are also included in this table.

*Countercurrent distribution.* Studies of the pepsin-treated, trichloracetic acid soluble fraction included use of the countercurrent distribution methods of Craig (*3*). The most satisfactory system found was water-phenol to which varying amounts of ether were added. This system was found to be capable of separating the activity from ninhydrin-positive but biologically inactive fractions. Its chief disadvantage is that emulsions form which require centrifugation before separations can be completed.

Figs. 1 and 2 show a typical fractionation made by countercurrent distribution. In Experiment B-28 (Fig. 1) a 12-plate distribution was made on a pepsin-treated, trichloracetic acid-soluble preparation with a potency of 18 times standard. The most active fractions (5 and 6) from Experiment B-28 were then subjected to a 24-plate run (Fig. 2), using the same system. Based upon total nitrogen, Fraction 12 from the second run had a potency

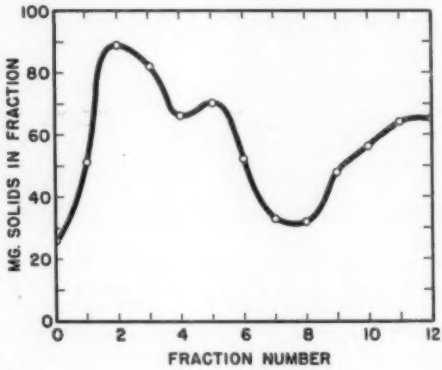


FIG. 1. Experiment B-28. A 12-plate distribution of peptic hydrolysate material having a potency that is 18 times standard.

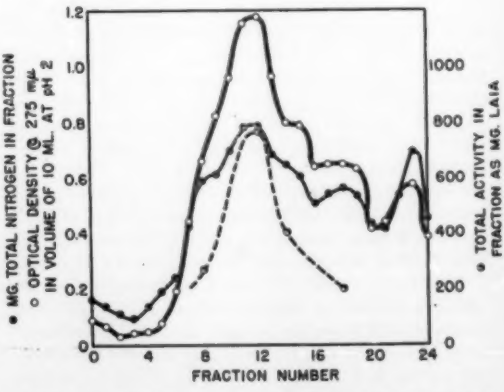


FIG. 2. Experiment C1. A 24-plate distribution made on Fractions 5 and 6 from Experiment B-28.

of 120 times standard, giving an over-all sixfold increase in biological potency.

The ultraviolet absorption spectrum of the most active fraction from Experiment C1 closely resembles those of proteins containing tyrosine and/or tryptophan and the parallelism between the absorption curve and the activity curve (Fig. 2) suggests that either or both of these amino acids is present in the active moiety.

Acid hydrolyzates of fractions from Experiment C1 were tested for amino acids by paper chromatography.[1] As shown in Fig. 3, 12 clearly defined ninhydrin-positive spots were obtained from Fraction 11, indicating at least 12 different amino acids. As shown in the legend below Fig. 3, it is not possible to resolve the pairs valine-methionine and leucine-isoleucine in the system used. Also, because of the proximity of phenylalanine to the leucine-isoleucine spot, it is possible that at least traces of phenylalanine were present. Finally, because an acid hydrolyzate was used, tryptophan was not identified in this experiment.

It is interesting to note that this highly potent fraction exhibits essentially the same amino acid composition as the pure protein of Li (*6*).

*Chromatography.* Studies employing paper in strips, columns, and chromatopiles; and starch columns, as well as adsorbing agents and ion exchange resins, have been carried out both for fractionation purposes and as analytical methods. In some of these procedures it has been possible to separate the major part of the biological activity from ninhydrin-positive material. Several of the highly potent preparations show negative ninhydrin reaction under the conditions employed.

*Ultracentrifugal experiments.* Through the courtesy of D. F. Waugh[2] a number of pepsin-treated, trichloracetic acid-soluble ACTH preparations were studied in the ultracentrifuge to determine the approximate molecular size of the active materials. ACTH fractions were dissolved in 0.05 *N* HCl, 0.5% NaCl, and run at 28.5° C for 12 hr at 60,000 rpm. Samples from the upper, middle, and lower portions of the cell were then assayed. As shown in Table 3, approximately 80% of the activity was found in the lower portion of the cell. Similar treatment of known proteins indicates that particles of molecular size of the order of 1,000 molecular weight would not sediment under these conditions, but that particles having molecular weight between 2,500 and 10,000 would behave in such a manner.

All of the results described indicate that the active moiety of the ACTH protein is of molecular size considerably greater than the ACTH peptides recently reported. It is not unlikely that the activity of the mixtures of peptides previously reported was due to the presence of a few percent of a larger molecule having a very high biological potency. Our results do not eliminate the possibility that adsorption of ACTH to larger

[1] Conducted by J. F. Roland and A. Gross of this laboratory.
[2] Department of Biology, MIT. A detailed report of the technique and results will be published shortly.

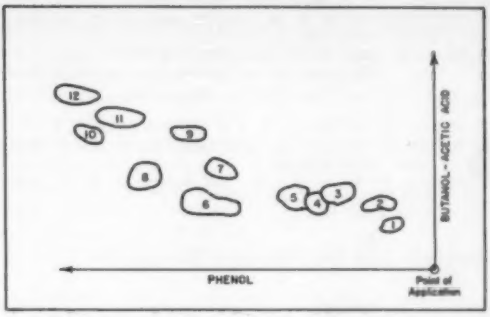


FIG. 3. Amino acid pattern for acid hydrolyzate of Fraction 11 from Experiment C1. Identification of spots is as follows: (1) cystine, (2) aspartic acid, (3) glutamic acid, (4) serine, (5) glycine, (6) lysine, (7) alanine, (8) arginine, (9) tyrosine, (10) proline, (11) valine (methionine), (12) leucine (isoleucine).

molecules has occurred. If such is the case, the complex is an extremely stable one that is resistant to pepsin and to acid hydrolysis, and no evidence for dissociation under any of the conditions described above has been observed. This is further substantiated by its behavior during electrophoresis, in the ultracentrifuge, in countercurrent distribution, and during starch and paper chromatography. On the other hand, presence of peptide linkages in the biologically active material is demonstrated by the fact that it is destroyed by trypsin, carboxypeptidase, and by complete acid hydrolysis. Efforts are continuing toward the isolation of a pure adrenocorticotropic hormone.

TABLE 3

SEPARATION OF ACTH ACTIVITY IN THE ULTRACENTRIFUGE

| Sample | Initial potency × La-I-A | Position in cell | Fractions: Initial: Proportion of activity % | Fractions: Initial: Activity mg La-I-A | Fractions: Final: Activity mg La-I-A | Fractions: Final: Proportion of activity % |
|---|---|---|---|---|---|---|
| CA-1 | 15 | Upper | 26 | 25.4 | 13 | 11 |
| | | Middle | 23 | 22.4 | 11 | 9 |
| | | Lower | 51 | 49.7 | 100 | 80 |
| | | Total | 100 | 97.5 | 124 | |
| PC-2 | 35 | Upper | 18 | 41.5 | 11 | 15 |
| | | Middle | 18 | 41.5 | 4 | 5 |
| | | Lower | 63 | 142 | 56 | 80 |
| | | Total | 100 | 225 | 70 | |

## References


1. BRINK, N. G., MEISINGER, M. A. P., and FOLKERS, K. *J. Amer. chem. Soc.*, 1950, **72**, 1040.
2. CORTIS-JONES, B. *et al. Biochem. J.*, 1950, **46**, 173.

3. CRAIG, L. C. *J. biol. Chem.*, 1944, **155**, 519.
4. LI, C. H., EVANS, H. M., and SIMPSON, M. E. *J. biol. Chem.*, 1943, **149**, 413.
5. LI, C. H. *Fed. Proc.*, 1949, Part I, **1**, No. 1, 219.
6. ———. *Symposium on the Adrenal Cortex*, AAAS, New York City, (Dec., 1949). Manuscript presented by D. J. Ingle.
7. MORRIS, P. and MORRIS, C. J. O. R. *Lancet*, 1950, **1**, 117.
8. SAYERS, G., WHITE, A., and LONG, C. N. H. *J. biol. Chem.*, 1943, **149**, 425.
9. SAYERS, M. A., SAYERS, G., and WOODBURY, L. A. *Endocrinology*, 1948, **42**, 379.

## Sanitary Seal for Infrared Microcells

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When biological extracts are analyzed through infrared absorption studies, cells having sample volumes of the order of 25 mm³ are often required. The sample is usually contained between two sodium chloride windows for infrared transparency and in a metal cell body for rigidity. Cells suitable for such work should have: (a) sample volumes consistent with adequate absorption thicknesses; (b) a construction which permits ease of assembly, filling, emptying, and cleaning; and (c) a seal between the windows and cell body which does not contaminate the sample or its solvent. Cells which have met requirements (a) and (b) have been reported (*2–5*), and seals based upon cemented (*5*), gasketed (*1, 2*), or amalgam-sealed joints (*3, 4*) have been described. However, because of the excellent solvent action of the commonly used diluents, $CS_2$ and $CHCl_3$, difficulties resulting from contamination, assembly, or accurate determination of absorption thickness have been experienced. The last-mentioned difficulties can be removed if the use of the intermediary material between the windows and cell body is eliminated and a seal resulting from adhesive attraction is used. A successful technique for such seals is described as it is used in a typical cell employed in ketosteroid absorption studies (Figs. 1 and 2).[3]

Both the sodium chloride windows and the cell body must be finished flat enough for adhesion to result. For the metal body, this is accomplished through a finishing technique of grinding and lapping before the cell fittings are added, but after all other machining operations have been completed. Superfinish can be substituted for lapping, but it is to be noted that flatness rather than smoothness alone is required. This limits the choice of material for the cell body, which should be easily machinable and have proper surface characteristics to permit finishing to optical flatness. Both these requirements can be met through the use of brass or mild steel for cell body machining and a hard, chemically inert plating for surface finishing. The cell body shown in the figures was made from mild steel and plated with hard chromium 0.001 in. thick. To prevent the slight increase in the plating thickness and a porous surface along the periphery of the cell body during plating, which was anticipated from the electrical gradient concentration and increased current density along the outer edge, the cell body was surrounded by a close-fitting ring ground with it to the same thickness. That similar precautions with regard to the fitting holes and cell openings were not required probably resulted from the small size of these openings relative to the body surface. The resulting surface is hard, a fact which permits finishing to optical flatness with cast iron laps and silicon carbide flour pastes.

The sodium chloride crystals were finished through the commonly used rouge lapping technique. Large soft

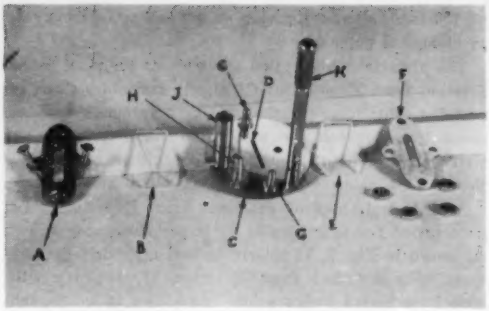


FIG. 1. Disassembled absorption cell. *A*, front cover plate; *B*, front sodium chloride window; *C*, cell body; *D*, front aperture; *E*, rear window; *F*, rear cover plate; *G*, cover plate studs (internally and externally threaded); *H*, hypodermic filling needle; *J*, syringe fitting for emptying and cleaning; *K*, handle. Holes in *C* connect *H* and *J* to the sample container.

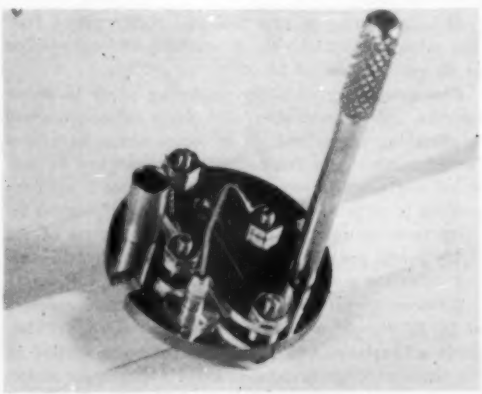

FIG. 2. Assembled absorption cell. Cell body dimensions: thickness 3.00 mm; diam 32.25 mm; front aperture 1.00 mm wide by 12.0 mm long; rear aperture 0.50 mm wide by 12.0 mm long. Window dimensions: 10 mm by 20 mm by 1 mm thick. Sample volume 25 mm³.

[1] At present at the National Cancer Institute, on assignment to MIT, Cambridge, Mass.

[2] The author is indebted to Drs. K. Dobriner and J. D. Hardy for presenting the problem and having the seal tested.

[3] The first cells of this type were due to the excellent efforts of Mr. R. J. Zabelicky, of the Sloan-Kettering Institute Instrumentation Shop.

crystals can be lapped to flatnesses of the order of three rings of sodium light. Though this is difficult to obtain with small, thin crystals, the thinness of the crystal and its soft surface permit a satisfactory seal when it is clamped to the metal body. Seals of this type were found to hold $CS_2$ for several hours without any perceptible signs of leakage.


**References**

1. Broadley, H. R. *Rev. sci. Instr.*, 1948, **19**, 7.
2. Coggeshall, N. D. *Rev. sci. Instr.*, 1946, **17**, 9.
3. Colthup, N. B. and Williams, V. Z. *Rev. sci. Instr.*, 1947, **18**, 12.
4. Williams, V. Z. *et al. Rev. sci. Instr.*, 1948, **19**, 3.
5. Wollman, S. H. *Rev. sci. Instr.*, 1949, **20**, 3.


## Electromagnetic Enrichment of $Fe^{58}$ Content and Concurrent Impoverishment of $Fe^{54}$ Content in Iron[1]


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The radioactive isotope $Fe^{59}$ (half-life = 47 days) is important in physiological studies. It can be produced in the thermal neutron reactor by the following reaction: $Fe^{58}$ (n, $\gamma$) $Fe^{59}$. The $Fe^{54}$ content of the iron being irradiated must be low to minimize the formation of $Fe^{55}$ (half-life = 4 years) by the reaction: $Fe^{54}$ (n, $\gamma$) $Fe^{55}$.

TABLE 1

Abundance of Fe Isotopes in Iron Enriched in $Fe^{58}$

| | (a) Shipment No. 1 | (b) Shipment No. 2 | (c) Best collection | (d) Natural abundance |
|---|---|---|---|---|
| | % | % | % | % |
| $Fe^{54}$ ..... | 0.8 | 0.6 | 0.3 | 5.81 |
| $Fe^{58}$ ..... | 50.4 | 21.0 | 12.3 | 91.64 |
| $Fe^{57}$ ..... | 6.9 | 2.7 | 1.4 | 2.21 |
| $Fe^{56}$ ..... | 42.0 | 75.7 | 86.0 | 0.34 |
| $Fe^{58}/Fe^{54}$ ratio | 53 | 126 | 287 | 0.06 |

The normal abundances of $Fe^{58}$ (0.34%) (*1*) and of $Fe^{54}$ (5.81%) (*1*) and the neutron cross sections of $Fe^{58}$ (0.36 barn) (*2*) and of $Fe^{54}$ (2.5 barns) (*2*) favor the formation of the long-lived $Fe^{55}$ when normal iron is irradiated by neutrons. Iron enriched in $Fe^{58}$ and impoverished in $Fe^{54}$ has been produced electromagnetically in the calutrons at the Y-12 Research Laboratory. Table 1 summarizes mass analyses of three representative $Fe^{59}$ collections. Columns (a) and (b) are the analyses of two shipments of $Fe^{58}$ that have been used for the production of $Fe^{59}$ low in $Fe^{55}$ by neutron irradiation. Column (c) summarizes the best collection of $Fe^{58}$ to date and is illustrative of the quality that can be obtained.

The accomplishments reported here are the combined efforts of the professional and operational personnel performing calutron operations and associated chemistry. Particular credit is due L. O. Love, W. A. Bell, E. H. Swanson, S. F. Fairbourne, and L. O. Gilpatrick. The mass analyses of the enriched isotopes were done under the direction of R. F. Hibbs.


[1] This report is based on research carried out under contract for the Atomic Energy Commission by the Isotope Research and Production Division at the Carbide and Carbon Chemicals Corporation, Y-12 Research Laboratory, Oak Ridge, Tennessee.



**References**

1. Seaborg, G. T. and Perlman, I. *Rev. mod. Phys.*, 1948, **20**, 585.
2. Way, K. and Haines, G. *Atomic Energy Comm. Doc.*, 1948, AECD-2138.


## The Eosinophil Response: Immediate vs. Delayed Eosinopenia[1]


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With the growing interest in physiology of the adrenal cortex, the eosinophil response has become an important criterion of adrenal cortical discharge. In fact, it is reputed to be the most sensitive indicator of release of C-11 type steroids from a functioning adrenal cortex. In man the administration of either adrenocorticotropic hormone (ACTH) (*3*, *7*), Compound E (*3*, *5*), or epinephrine (*4*, *6*) produces an eosinopenic response which occurs gradually, reaching its maximum in 3–4 hr. The fate of the disappearing eosinophils remains an unsolved mystery.

In this study, the eosinophil response to epinephrine and histamine was observed in a series of unanesthetized, trained dogs. Dunger's method was employed in counting the circulating eosinophils (*1*). All drugs were injected intravenously. Histamine and epinephrine[3] solutions were infused at a constant rate over a 60-min period. Two control counts were done on each animal prior to administration of any drug. If variation in the two counts exceeded 10%, a third count was made and the average taken as the base line. Statistical analysis of a series of hourly counts on eight dogs in control experiments revealed a mean coefficient of variation of 5.6%, with a range of 3.2%–13.5%. Changes in counts were recorded as percent deviations from the control counts.


[1] This study was aided by grants from the Office of the Surgeon General, Department of the Army, and the Chicago Heart Association.

[2] Public Health Service Research Fellow of the National Heart Institute.

[3] Epinephrine used was obtained through the kindness of Dr. E. A. Sharp of Parke-Davis & Co.

Following infusion of histamine (5 μg/kg/min), the eosinophil count dropped precipitously within the first 10–15 min and then slowly rose to about 60% of the control values (Fig. 1). In striking contrast, epinephrine infusions effected a gradual eosinopenia which reached a maximum in 4 hr. The intravenous administration of large doses of ACTH[4] or adrenal cortical extract[5] also produced the delayed type of eosinopenic reaction. These data are summarized in Table 1. Although variability in eosinopenic responses is marked, there are statistically significant differences in the 15-min responses between histamine (5 μg/kg/min) and ACE (10 ml) ($t = 16.1$ and $P < 0.01$); and also between histamine (5 μg/kg/min) and ACTH ($t = 14.9$ and $P < 0.01$). With the 0.5-μg/kg/min dose of histamine, the responses were variable, since this dose was very close to threshold.

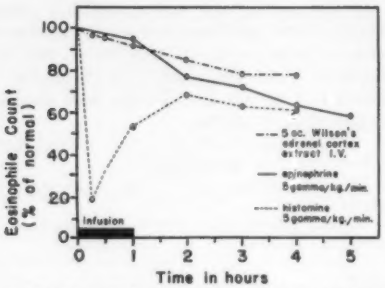


FIG. 1. The immediate vs. the delayed eosinopenic response in the dog.

The delayed eosinophil response following epinephrine infusion might be due to time required to activate the pituitary adrenal mechanism. The delayed response following intravenous injection of ACTH could be due to time required to activate the release of C-11 steroids from the adrenal cortex in addition to their action in effecting eosinopenia. The delayed response to intravenous administration of aqueous adrenal cortical extract suggests that the major time factor is concerned with action of the C-11 steroids on the eosinopenic response.

The fact that adrenal cortical extract requires several hours to produce eosinopenia in the dog strongly suggests that the immediate type of eosinopenia effected by histamine is mediated through some other eosinopenic pathway. These experiments do not rule out the possibility that much larger doses of adrenal extract might also effect the immediate type of eosinophil response.

TABLE 1

EOSINOPHIL RESPONSES OF THE DOG TO HISTAMINE, EPINEPHRINE, ACTH, AND ADRENAL CORTICAL EXTRACT

| Drug used | No. of dogs | Mean % decrease in eosinophil response | | | | | |
|---|---|---|---|---|---|---|---|
| | | Time after injection (min) | | | | | |
| | | 15 | 30 | 60 | 120 | 180 | 240 |
| Histamine* | | | | | | | |
| 5 μg/kg/min i.v.† | 5 | 82 | 68 | 47 | 32 | 38 | 40 |
| (s)‡ | | ( 9.0) | ( 2.2) | (10.0) | ( 8.7) | ( 7.8) | (10.0) |
| 0.5 μg/kg/min i.v.† | 6 | 31 | 16 | 13 | 14 | 13 | 10 |
| (s) | | (16.6) | (11.1) | (13.4) | ( 7.9) | (11.5) | ( 9.5) |
| Epinephrine | | | | | | | |
| 5 μg/kg/min i.v.† | 4 | 7 | 11 | 10 | 21 | 34 | 36 |
| (s) | | ( 6.0) | ( 5.8) | ( 9.7) | (14.5) | (11.6) | ( 6.9) |
| ACE§ | | | | | | | |
| 5 ml i.v. | 7 | 2 | 3 | 8 | 16 | 24 | 22 |
| (s) | | ( 1.3) | ( 7.5) | ( 6.7) | (11.9) | ( 6.7) | ( 9.2) |
| 10 ml i.v. | 4 | 10 | 13 | 18 | 26 | 31 | 32 |
| (s) | | ( 8.8) | ( 8.8) | (16.0) | (13.1) | (15.5) | (15.0) |
| ACTH | | | | | | | |
| 50 mg i.v.‖ | 5 | 20 | 19 | 14 | 27 | 43 | 55 |
| (s) | | ( 2.7) | ( 8.6) | ( 9.4) | ( 5.4) | ( 4.5) | ( 8.1) |
| Post. pit.¶ | | | | | | | |
| 4 pressor units i.v. | 4 | 13 | 21 | 30 | 28 | 21 | 19 |
| (s) | | (16.0) | ( 6.9) | (11.2) | ( 7.7) | ( 0.5) | ( 2.9) |

* Dose of histamine calculated as free base.
† Sixty-minute infusion given intravenously (i.v.).
‡ Estimate of standard deviation from ratio, range/s. (s).
§ Aqueous adrenal cortical extract (Wilson and Co.)
‖ Dose of ACTH equivalent to 50 mg of standard (Armour and Co.).
¶ Control for posterior pituitary impurities in ACTH.

These data suggest that in the dog there are at least two types of eosinopenic responses: an immediate, and a gradual or delayed type. It is possible that the immediate type of eosinopenia is not mediated through the release of C-11 adrenal steroids. The data emphasize that eosinopenic responses must be evaluated in terms of both time and magnitude.

[4] We are indebted to Dr. Edwin Hays of Armour & Co. Laboratories for a generous supply of ACTH.
[5] We wish to thank Dr. David Klein of Wilson & Co. Laboratories for a generous supply of aqueous adrenal cortical extract.

**References**

1. DUNGER, R. *Münch. med. Wschr.*, 1910, **57**, 1942.
2. FORSHAM, P. H. *et al. J. clin. Endocrinol.*, 1948, **8**, 15.

3. FORSHAM, P. H. *et al. J. clin. Invest*, 1949, **2**, 660.
4. LARAGH, J. H. and ALMY, T. P. *Proc. Soc. exp. Biol. Med.*, 1948, **69**, 499.
5. PEREIRA, G. A. *et al. Amer. J. Med.*, 1949, **7**, 56.
6. RECANT, L., FORSHAM, P. H., and THORN, G. W. *Program Assn. Study int. Secretions*, 1948, 19.
7. SAYERS, G. *et al. J. clin. Endocrinol.*, 1949, **9**, 593.
8. SNEDECOR, G. W. *Statistical methods.* Ames, Iowa: Iowa St. Coll. Press, 1946.

## Centrifugation as an Aid in Examining and Fixing Rotifers

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During the course of limnological work involving the centrifugation of samples of lake water, it was noticed that the behavior of some rotifers was markedly affected. In particular, a *Kellicottia bostoniensis* was observed lying with its head expanded, mastax in operation, and otherwise behaving nearly normally except that the cilia were motionless, although distinctly visible. This fact permitted very close observation of details of the corona, which are frequently difficult to see.

Therefore, a sample of rotifers, rich in species and individuals, was obtained, and subsamples were subjected to centrifugation for varying lengths of time at about 670 *G*, using 100-ml tubes in a size 1, type SB International centrifuge running at 2000 rpm. Behavior of the rotifers was little affected by 5 min of centrifugation, but 10 min or more resulted in marked alteration of the behavior of some species, as compared with an uncentrifuged sample in a watch glass. Centrifugation at about 320 *G* in a standard clinical model centrifuge had effects that were similar but somewhat delayed..

Several species, after centrifugation for 10 or 20 min, began to swim more and more slowly, with the corona expanded fully or more fully than usual, and some individuals lay quietly with the cilia moving very feebly. In only a very few specimens did all the coronal cilia stop moving as in the first *Kellicottia* seen. After 30 min, a greater proportion of the animals were still, but distortion of some species was quite marked. *Polyarthra trigla*, which has a rather stiff body cuticle, was not distorted appreciably. In the loricate *Keratella quadrata*, the corona bulged out farther than usual, without being seriously distorted, but two illoricate species, *Asplanchna priodonta* and *Epiphanes brachionus*, were quite distorted. The small, loricate *Pompholyx sulcata* seemed unaffected and continued to swim very freely.

Further, when a few drops of 40% formaldehyde were added to a sample in a watch glass, many of the affected rotifers remained expanded, some of them displaying the cilia of the corona very clearly. In any rich sample fixed this way, a few individuals of some species usually remained expanded, possibly those which were moribund. Apparently centrifugation increases the probability that an animal will remain expanded when formalin is added. This increase is large enough to make centrifugation a worth-while addition to the battery of methods of fixation of rotifers.

It may be anticipated that the effect of centrifugation on various species of rotifers will be found to vary with several factors such as temperature and time and force of centrifugation. Centrifugation appears to be a useful adjunct to standard methods of narcotization and fixation and should give useful results, especially when coupled with methods of fixation rather more refined than that described above. The method worked well for *Kellicottia bostoniensis, Keratella quadrata, Platyias patulus, P. quadridentata,* and *Polyarthra trigla.* It did not work well with *Asplanchna priodonta, Epiphanes brachionus, Lepadella patella, Filinia longiseta,* or *Pompholyx sulcata.* The subjective criterion for "working well" was whether several specimens good enough to be included in a museum collection were obtained at one operation.

A method of fixation that has worked remarkably well with many rotifers without preliminary narcotization and which, in connection with centrifugation, is capable of giving very satisfactory results, has been developed by F. J. Myers. Its success in skillful hands is attested by the excellence of the slide collections at the American Museum of Natural History in New York City and the Academy of Natural Sciences in Philadelphia.

As many rotifers as possible are concentrated in 5 or 10 ml of water, and then put into a Syracuse dish and distributed evenly about the dish. Rotifers may be concentrated either with a plankton net or with light, as described by Myers (*2*). Sessile rotifers should be put in attached to fragments of their substrate, which can be trimmed down with iridectomy scissors. An equal amount of water is then boiled in a test tube, and the violently bubbling water is poured into the center of the Syracuse dish. Evidently, in a certain temperature range, the rotifers die extended, and there will be an annular region in the dish where nearly perfect fixation takes place. Inside this region they will be distorted by heat; outside they will be contracted or not even killed. (Needless to say, individuals must be expanded when the hot water is applied.) Formalin or other fixative is then added, and the rotifers may be mounted or stored indefinitely. It should be realized that with each fixation only a few individuals in a dish will be perfectly fixed, and all must be examined. This method has worked successfully on species that have not been fixed extended by any other means, even narcotization with cocaine or neosynephrin, and is better for most sessile species than any other method, even the method described previously by the present writer (*1*). With a little practice it can be made to work with the notoriously difficult belloid rotifers so well that the taxonomically important folds and wrinkles of the cuticle and shape of the corona and cilia are preserved with considerable exactitude, making work much easier because fixed material may be used rather than the living animals, which heretofore have been necessary. The method has been used successfully in the field.

**References**

1. EDMONDSON, W. T. *Science*, 1936, **84**, 444.
2. MYERS, F. J. *Amer. Mus. Novit.*, 1934, #761, 1.

# A Comparison of Meteor Activity with Occurrence of Sporadic E Reflections

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In a previous paper (*3*), the writer presented evidence to show that the character of the echo obtained from a trail of ionization produced by a meteor is different in character from the echoes frequently obtained on ionosphere recorders and described as sporadic E reflections. Since the presentation of that paper a statistical study has been carried out on the frequency of reflections obtained with the meteor equipment in operation by the Central Radio Propagation Laboratory of the National Bureau of Standards, and the frequency of occurrence of sporadic E reflections observed over the same interval with the automatic multifrequency ionosphere recorder operated by the laboratory.

By sporadic E, also sometimes called abnormal E, is meant what Lovell (*2*) referred to as long duration abnormalities in the E region as distinguished from what Appleton and Naismith (*1*) referred to as ionization bursts. In the scaling of sporadic E data from the vertical incidence ionosphere records, extreme care was taken to see that only reflections of the sporadic E type were scaled.

Evidence of a statistical nature has been found by some investigations which tends to show that meteors are responsible for sporadic E reflections (*1*, *2*). These findings are not in general confirmed by the result of the present investigation.

The equipment used in this study consists of the Bureau's regular meteor equipment and the regular C2 automatic multifrequency ionosphere recorder.

The meteor-detection equipment comprises a transmitter emitting pulses at 27.2 megacycles per sec of approximately 50-μsec duration at a rate of 60 pulses/sec, a suitable receiver, and an automatic echo recorder employing a recording milliammeter. The equipment is fully automatic and capable of unattended operation. The maximum available peak-power output from the transmitter is approximately 16 kw at full plate voltage. For automatic operation the power is reduced; all the meteor data discussed in this report were obtained with approximately 8-kw output. The receiver-recorder sensitivity is adjusted to record any echo of 5 μv or more at the receiver input terminals. Circuits are included which afford some discrimination against noise and continuous wave interference. The transmitting and receiving antennas are identical half-wave dipoles one quarter-wave aboveground.

The meteor equipment was operated continuously over the period November 1, 1948, to April 30, 1949, inclusive, except for a few intervals when power or equipment failures occurred. Sometimes the recording was partially obscured by strong interference. In such cases, those echoes occurring during the clean portion of the record were counted to establish the hourly rate. The greatest interference was encountered during the day and was due largely to other activities in progress at the observing site. During such times visual observations of a cathode-ray tube were made to supplement the automatic record. Every effort was made to keep the sensitivity of the equipment constant. The receiver-recorder sensitivity and transmitter power were checked and entered in the log book on a regular schedule. The data include a total of over 62,000 meteor reflections.

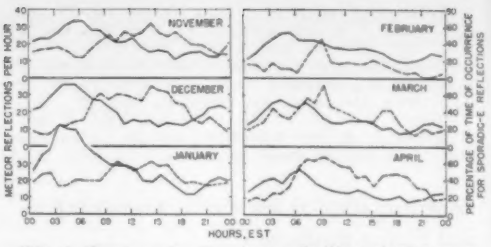


FIG. 1. Hourly rate of meteor reflections at 27.2 megacycles (solid line) and percentage of time of occurrence of sporadic E reflections (broken line) 1948–1949.

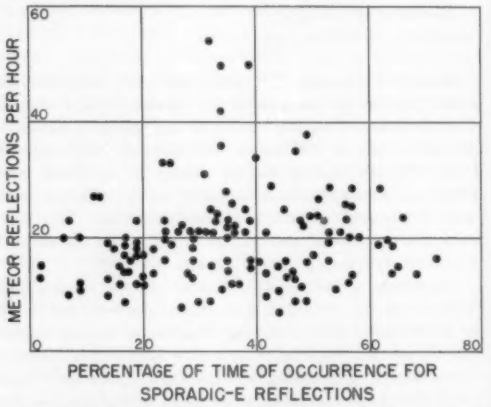


FIG. 2. Comparison of rates of meteor reflections at 27.2 megacycles and sporadic E reflections for single days, November 1, 1948–April 30, 1949.

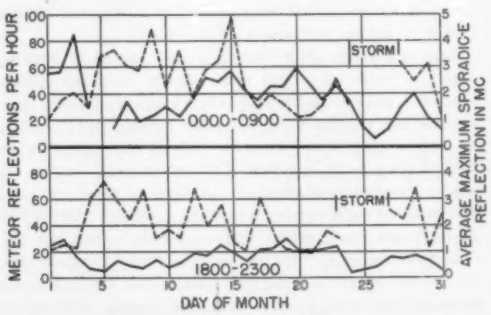


FIG. 3. Day-to-day variation in meteor reflections per hour (solid line) and average maximum radiofrequency at which sporadic E reflections were observed (broken line), January 1949.

The ionosphere recording equipment comprises a transmitter emitting pulses of approximately the same characteristics of duration, repetition frequency, and peak power as those from the meteor equipment; a receiver; and a camera recorder. The antenna is a modified rhombus oriented so that the main lobe is directed upward.

The ionosphere recorder operated automatically, obtaining records of the ionosphere layer heights and critical frequencies every 15 min. Few records were lost from failure of equipment or other causes. During the period of observation 16,700 ionospheric records were obtained.

Data from the two recording devices consist of (a) frequency of occurrence of reflections from meteor trails as indicated by the distinct and characteristic short duration echoes observable on an oscilloscope screen, and (b) the frequency of occurrence of reflections from E layer heights commonly interpreted as sporadic E reflections ($E_s$), as well as values of $fE_s$ (maximum $E_s$ reflection frequencies in megacycles) for each hour. The ionospheric records during the period were scaled independently of the reductions of the meteor data. The majority of the scalings of these ionospheric records were performed by an observer having no knowledge of the meteor data. Thus, as far as possible, effects of personal prejudice in the scaling of the records were eliminated. The results are presented in Figs. 1, 2, and 3.

Fig. 1 shows the diurnal variation of the frequency of occurrence of meteor reflections as compared with the percentage of time of occurrence of sporadic E reflections throughout the day. Average values are presented for each of the months in the period from November 1948 to April 1949. The meteor reflection rates exhibit characteristic maxima at about 0600 EST, while the $E_s$ exhibits maxima around midday. It is possible that the $E_s$ curves are biased by the diurnal variations of absorption. If so, the effect is to lower the occurrences during midday when absorption is at maximum. If corrections were to be applied to the curves to correct for this effect, they would result in increasing the midday maxima and could not bring the two sets of curves into better agreement. The absorption at the 27.2-megacycle frequency used for obtaining meteor reflections is, of course, very low and could not be expected to alter the curves noticeably.

A scatter diagram of percentage of time occurrence for $E_s$ plotted against the meteor reflection rates is presented in Fig. 2. Lack of any appreciable correlation between the two quantities is evident. The data for January, which were the most continuous for any of the months under consideration, are plotted in Fig. 3 to show the day-to-day average broken down into dichotomous groupings from 0000 to 0900 hr and from 1800 to 2300 hr. In this case, the average value of $E_s$ at any hour is used instead of the percentage of time occurrence. Lack of any similarity between these two curves is apparent. Interest attaches to the high hourly rate of meteor reflection in the morning hours during the first part of January—a result of the Quadrantid shower.

These data seem to warrant the conclusion that the frequency of occurrence of sporadic E reflections is unrelated to meteor phenomena, at least to those which can be detected at 27.2 megacycles. Of course, it may still be argued that sporadic E reflections are caused by meteors having such low energy or other characteristics that they escape detection by the radiofrequency used. This, of course, would require that the distribution of these hypothetical particles have a different frequency of occurrence from the distribution of those that are detectable. As far as is known there is no theoretical basis for such an assumption.

### References


1. Appleton, E. V. and Naismith, R. *Proc. phys. Soc. Lond*, 1947, **59**, 461.
2. Lovell, A. B. C. *Rep. Prog. Phys.*, 1948, **11**, 415.
3. Pineo, V. C. *Science*, 1949, **110**, 280.


## Polymers from Chicle


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Two polymeric unsaturated hydrocarbons are found in plants—caoutchouc (rubber) and gutta (gutta-percha). Formally, both are considered to be derived from isoprene and are believed to differ in the spatial configurations of the carbon atoms around the double bonds (*1, 4, 5*), caoutchouc being the *cis*-, and gutta, the *trans*-configuration for chain continuation.

Recently, publications have appeared in which attempts to find both caoutchouc and gutta in material obtained from the same plant source were unsuccessful (*3, 6*). In one of these publications (*6*) chicle is reported to contain only the isomer corresponding to gutta.

Studies in this laboratory have indicated the existence of both types of hydrocarbon in commercial chicle. X-ray (*2*) and infrared absorption spectrum data[1] confirm the identification of the two polymers isolated with caoutchouc and gutta. Outlined here are methods used in this laboratory for separation of the two polymers.

Chicle used was the commercial product selected from lots believed to be as nearly as possible "pure," i.e., the product of a single species of tree. This chicle was melted, strained, and centrifuged in the molten state to remove bits of bark, stones, and similar impurities. The molten centrifuged chicle was cooled and allowed to stand at room temperature for about 1 week before benzene extraction.

For separation of the polymers, 1600 g of centrifuged chicle was treated with 2400 ml of thiophene-free benzene and allowed to stand for 24 hr at 30°–35° C with occasional shaking to insure complete dispersion. This mixture was then centrifuged to separate the transparent yellow-brown benzene solution from the insolubles. To the benzene solution was then added, with stirring, 4,800


[1] We are grateful to Baird Associates, Inc. for infrared absorption spectrum curves on these materials.

ml of absolute ethyl acetate, and the mixture was set in the refrigerator overnight.

The crude gutta which separated was filtered with suction on a Büchner funnel and rinsed twice with 100-ml portions of ethyl acetate. Yield of crude gutta was 219 g or 13.7% of starting chicle.

This gutta was extracted in a Soxhlet apparatus with acetone for 24 hr to remove waxy and resinous impurities. The acetone-extracted material was then extracted for 24 hr in a Soxhlet apparatus with peroxide-free ethyl ether. The insoluble extracted gutta was air-dried to constant weight. Gutta obtained by this procedure was found to melt at about 69°–71° C (the melting point varying slightly from sample to sample) and is believed to correspond to the α-form of gutta from gutta-percha or balata. A lower melting form (mp 64°–66° C) may be obtained by melting this gutta and cooling rapidly or by recrystallizing from petroleum ether or other solvents.

The caoutchouc-type polymer was precipitated from the filtrate after filtering off the crude gutta, by addition of 5,000 ml of acetone, with stirring, to the clear benzene-ethyl acetate solution. The polymer began to precipitate immediately, and was separated, after 24 hr of standing in the refrigerator at 5° C, by centrifuging. Addition of a small amount of electrolyte (KI) to the mixture results in more complete precipitation of the polymer and allows it to be separated from the supernatant mother liquor simply by decanting. Yield of crude caoutchouc-type polymer was 76 g or 4.8% of starting chicle.

This polymer was purified by a 24-hr extraction in a Soxhlet extractor with acetone, and then it was dissolved in benzene (by standing overnight), filtered through filter paper, and reprecipitated with acetone. Supernatant mother liquor was decanted from the precipitated polymer, which was then rinsed with acetone and dried in a vacuum desiccator.

Osmometric molecular weight studies on the two types of polymers gave the following figures: gutta, 16,000; caoutchouc, 91,000. Infrared absorption spectrum measurements in the range of 2.5 μ–15 μ indicate that the gutta and caoutchouc isolated from chicle are lower molecular weight equivalents of polymers from gutta-percha (Pahang) and rubber (*Hevea*, pale crepe), respectively. They are also believed to correspond to the cold ether-insoluble and cold ether-soluble hydrocarbons isolated by Prochazka and Endemann (1879), and cited by Schereschewski (7).

The procedure outlined has yielded the two polymeric types when applied to a number of commercial chicle samples obtained from widely separated geographic locations. Samples of chicle before centrifuging have also been found to yield the two types of polymer.

Details of experimental procedures and physical measurements will be published later.

### References


1. Bunn, C. W. *Rubber Chem. and Tech.*, 1942, **15**, 704.
2. Hampton, R. R. Private communications.
3. Hendricks, S. B., Wildman, S. G., and Jones, E. J. *Arch. Biochem.*, 1945, **7**, 427.
4. Mark, H. *Physical chemistry of high polymeric substances.* New York: Interscience, 1940. P. 175.
5. Meyer, K. H. *Natural and synthetic high polymers.* New York: Interscience, 1942. P. 119.
6. Saunders, R. A. and Smith, D. C. *J. appl. Phys.*, 1949, **20**, 953.
7. Schereschewski, E. *Über balata und chicle.* Doctoral dissertation, University of Bern, 1906.


## Several Effects of Maleic Hydrazide on Plants


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Schoene and Hoffman (*2*) illustrated that maleic hydrazide, applied as a spray at a concentration of 2000 ppm, temporarily inhibited stem growth of tomato, and they reported that plants showing this response resumed growth from lateral buds about two months after treatment. They also observed that some chlorosis appeared and that root growth was inhibited. Temporary stoppage of shoot growth was also recorded for several other species.

The writer began to test the effects of the diethanolamine salt of maleic hydrazide on a variety of plants shortly after the report, just cited, was published. Concentrations of 2,400 and 600 ppm of the active ingredient were arbitrarily chosen for preliminary work. To a water solution of the salt enough of the detergent, Tide, was added to assure satisfactory wetting of leaves. The mixture was applied on warm, sunny days with a 3-gal compressed-air sprayer or with a nasal atomizer. Testing was done both out of doors and in the greenhouse.

Easily visible effects on plants included: (1) a temporary suspension of stem elongation from terminal buds or death of terminal buds and adjacent tissues, (2) expansion of lateral buds some time after the terminal bud had been affected, (3) a transient intensification of green in leaves of stunted plants, (4) a localized accumulation of anthocyanins or other nongreen pigments, (5) narrowing of leaves on both monocots and dicots, (6) several patterns of leaf chlorosis, (7) an interference with water absorption, apparently caused by death of root tips, (8) suppression of nodule formation on bush beans, and (9) total, temporary, or male sterility.

Stunting was common, but not a universal result of treatment. It was soon followed by an unmistakable intensification of green in the leaves of nimblewill (*Muhlenbergia schreberi*), Kentucky bluegrass (*Poa pratensis*) grown in shade, dayflower (*Commelina virginica*), bush bean (*Phaseolus vulgaris*), and two varieties of hybrid sweet corn (*Zea mays* var. *saccharata*).

Crabgrass (*Digitaria sanguinalis* and *D. ischaemum*), one variety of field corn (*Zea mays* var. *indentata*), and hybrid Golden Delicious sweet corn, all of which have the capacity to produce anthocyanins, developed considerable amounts of these pigments in the younger leaves, which had received the higher concentration of maleic hydrazide. The petals of dayflower were about half-normal

size and were deeper blue than normal petals. The common violet (*Viola* sp.) frequently developed a dull purplish pigment in treated leaves.

Leaves that expanded subsequent to treatment were narrowed on two varieties of sweet corn, one variety of field corn, on bush bean, Kentucky bluegrass grown in shade, crabgrass, sunflower (*Helianthus annuus*), and red coleus (*Coleus blumei*). Several distinctive patterns of chlorosis were observed on these plants.

Interference with water absorption by roots was clearly evident in sweet corn and garden beet (*Beta vulgaris*) sprayed with 2,400 ppm of maleic hydrazide. These crops, grown in the field, in the full sun, wilted severely at the same time that untreated plants in the same rows remained turgid. Plants of field corn grown individually in small flowerpots in the greenhouse were used to observe the effects of maleic hydrazide on roots. In this exploratory test, four plants were treated and four were used as controls. An application of 2,400 ppm to the leaves caused root tips to die and turn brown, and also inhibited the development of additional lateral roots. One month after treatment the total dry weight of new roots on treated plants was one-fourth that of new roots on control plants. If the treated corn plants in the field did not extend their roots into new soil any faster than the treated plants in the greenhouse, they would be expected to wilt (as in reality they did) soon after soil moisture had dropped to slightly below field capacity.

Maleic hydrazide applied at a concentration of 2,400 ppm resulted in total sterility of gladiola (*Gladiolus* sp.), owing probably to proper timing of the spray and to the fact that a gladiola corm gives rise to only one floral axis. Individual flower heads of China aster (*Callistephus chinensis*) were completely sterilized by applying the spray at the young-bud stage. Dayflower treated with 600 ppm of the chemical formed abortive flower buds for a time, but later produced flowers that set seed. Floral axes of nimblewill present when the spray was applied were apparently killed. The production of cleistogamous flowers on the common violet was interrupted for several weeks. Growth of spotted spurge (*Euphorbia maculata*) was checked for a short period but upon resumption of growth the leaves, flowers, and fruits appeared normal. The size of inflorescences and the number of seeds per cluster of crabgrass were greatly reduced for several weeks by the 2,400-ppm treatment. Dayflower, nimblewill, violet, spotted spurge, and crabgrass survived treatment because all of them can extend their vegetative body by growth from lateral buds. Thus, the sterilizing effect of maleic hydrazide was temporary on such plants if they did not die from water shortage after treatment. When sweet corn was treated at a critical stage with 600 ppm, it produced sterile tassels and stubby ears with functional silks. Pollen from control plants produced normal kernels on these small ears. The induction of sterility has not been previously reported for maleic hydrazide (*2*), but is stressed in a report on the *n*-aryl phthalamic acids (*1*).

Carrot (*Daucus carota*), cabbage (*Brassica oleracea* var. *capitata*), bearded iris (*Iris germanica*), lily-of-the-valley (*Convallaria majalis*), Jonathan apple (*Malus sylvestris*), common plantain (*Plantago major*), Kieffer pear (*Pyrus* sp.), and sweet potato (*Ipomoea batatas*) were apparently unaffected by even the higher concentration of maleic hydrazide.

More complete details of tests and a discussion of their possible significance will be published elsewhere.

### References


1. Hoffman, Otto L. and Smith, Allen, E. *Science*, 1949, **109**, 588.
2. Schoene, D. L. and Hoffman, Otto L. *Science*, 1949, **109**, 588.


## A New Microculture Slide


**Richard N. Shoemaker**

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In recent years the importance of mold taxonomy has increased, and many mycologists have felt the need of a good, inexpensive, versatile, and easily manipulated slide for microscopic examination of fungi. The slide about to be described has been used successfully in our laboratories for some time in both elementary and advanced studies, and has been found excellent for teaching purposes and for photomicrography.

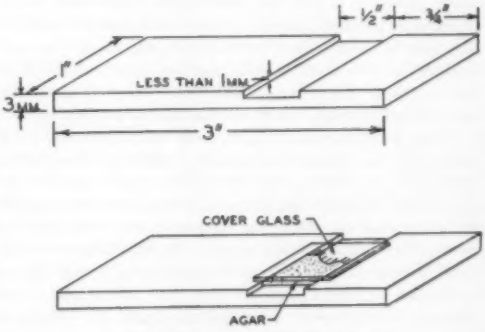


Fig. 1. Microculture slide in use.

The slide, which is used in conjunction with 18-mm cover slips, is a standard 1 in. × 3 in. glass slide, 3 mm thick, with an unpolished channel ½ in. wide and slightly less than 1 mm deep, located ¾ in. from one end of the slide (see Fig. 1).

Cover slips and slides are sterilized separately, and immediately prior to use a cover slip is placed over the channel without cement or wax of any kind, thus forming a small open chamber. Melted seeded agar is allowed to flow under the cover slip by capillarity until part of the space is filled. The inoculated culture slide may then be incubated in a moist chamber, such as a Petri dish containing a piece of moist cotton.

This slide makes possible the rapid production of temporary mounts and very satisfactory permanent mounts with little effort and negligible expense.

# Absorption and Translocation of Radioactive 2,4-DI by Bean Plants as Affected by Cosolvents and Surface Agents

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Radioactive iodine ($I^{131}$) has been used in tracer studies with 2-iodo-3-nitrobenzoic acid, a compound having plant growth-regulating properties (*6*). Stable 2,4-dichloro-5-iodophenoxyacetic acid (2,4-DI) and various derivatives of this acid were originally synthesized by the U. S. Department of Agriculture, and these were found to have plant growth-regulating activity (*5*). The method by which bean plants absorbed and translocated these stable iodo-phenoxy compounds appears, on the basis of visible responses, to be similar to that involved when they absorbed and translocated 2,4-dichlorophenoxyacetic acid (*1*). Methods of preparing radioactive 2,4-dichloro-5-iodophenoxyacetic acid (2,4-$DI^{131}$) and various derivatives in a radioactive form have also been described (*2, 5*).

In the present investigation a simple method of using these radioactive iodo-phenoxy compounds in the form of salts, esters, and acid has been devised and used to determine (1) the distribution of the acid and the morpholine salt in bean plants following absorption of the compounds by the leaves, and (2) the effect of different adjuvants on the rate at which these compounds are absorbed and translocated when applied to the leaves.

An applicator was designed with which measured volumes of a solution of isotopically tagged growth regulators were applied to the leaf surfaces of plants. By turning a threaded rod, pressure was applied to a rubber tube, one end of which was attached to a graduated pipette, the other end being closed. By this means a measured volume of liquid (0.01–0.02 ml) was forced out as a droplet on the tip of the pipette. This liquid was readily transferred by touching the tip of the pipette to the leaf surface of a plant.[1]

A cellophane disk was used in plating ground samples of radioactive plant material. A brass ring was pressed against the tacky surface of cellophane tape, and ground tissue of known weight was then evenly distributed over the tacky surface within the ring to make an even layer essentially one particle in thickness. Radioactivity of the sample was determined by means of an end-window Geiger-Müller counter, the counts being compared with those for a standard sample so that the results could be expressed in weight of 2,4-$DI^{131}$ present in the tissue.

In studying the distribution of 2,4-$DI^{131}$ acid[2] in plants following treatment of leaves, a weighed amount of the acid was dissolved in a measured amount of Tween 20 and sufficient water was added to make a mixture that contained 0.5% of Tween 20 and 10 μg of 2,4-$DI^{131}$ per 0.01 ml. One-hundredth ml of the 2,4-$DI^{131}$ acid mixture was applied to 0.5 $cm^2$ of surface on the upper side of each primary leaf of twenty selected bean plants. The plants used were of the Black Valentine variety. They had developed primary leaves that were about three-fourths expanded, and their first trifoliolate leaves were beginning to unfold. With a remote-control applicator, the treatments were placed within a lanolin ring stamped along the midrib about 1 cm from the petiole attachment (*1, 3*). Three days later the treated leaves were removed and discarded. Remaining parts were separated, dried at 80° C in a well-ventilated oven and ground to 40-mesh dimension, and the radioactivity of weighed aliquots of each sample was determined by the cellophane-disk method using a conventional end-window Geiger counter (*3*). Distribution of the morpholine salt of 2,4-$DI^{131}$ was studied in a subsequent experiment by methods identical with those described.

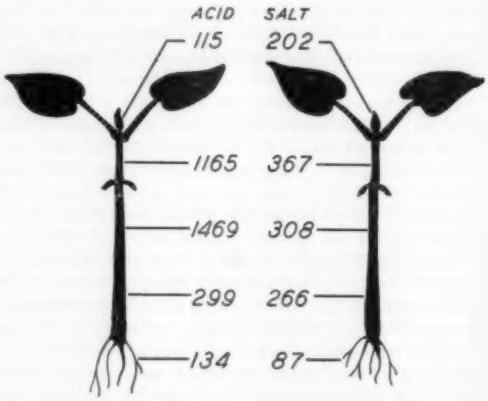


FIG. 1. Weight of 2,4-dichloro-5-iodophenoxyacetic acid (2,4-$DI^{131}$) and the morpholine salt of 2,4-$DI^{131}$ in various parts of bean seedlings. Numerals represent mμg of the chemicals detected in each part 3 days after treatment of each leaf with 10,000 mμg of acid or salt.

An average of 3,182 mμg (total application 20,000 mμg) of 2,4-$DI^{131}$ acid was translocated from the leaves to the main axis of plants used in the first experiment. In contrast, an average of only 1,248 mμg of the morpholine salt was moved from the leaves to the main axis of plants used in the subsequent experiment. Since these two experiments were not carried out simultaneously, the plants of each were not subjected to the same environmental conditions and this may have influenced to some extent the relative amounts of the salt and acid absorbed. The results are similar, however, to others obtained in an earlier preliminary experiment in which the rates of absorption of the acid and of the morpholine salt of 2,4-$DI^{131}$ were compared in a single experiment. In this earlier

[1] A detailed description of all methods referred to in this paper has been published as a U. S. Department of Agriculture mimeograph by the Bureau of Plant Industry, Soils, and Agricultural Engineering, December, 1949.

[2] $I^{131}$, obtained from the Atomic Energy Commission, was synthesized into 2,4-$DI^{131}$ by the Texas Research Foundation, Renner, Texas.

experiment it was found that when equimolar concentrations of the salt and acid were applied to the leaves, the bean plants translocated 23.6% more acid than salt, as was indicated by radioactivity in the stems determined after a 24-hr period of treatment.

In the present experiments, distribution of the acid and salt within the plant was similar, the greatest proportion of that absorbed being concentrated in the first internode and upper part of the hypocotyl, and the lowest in the roots (Fig. 1). Under the conditions used, an average of 17.6% of the morpholine salt, translocated to the main axis, accumulated in the terminal bud (parts above the second node); while only 3.6% of acid, translocated to the main axis, accumulated in this portion of the plants. The highest concentration of morpholine salt occurred in tissue of the terminal bud, while the highest concentration of the acid was centered in the first internode. Lowest concentrations were found in roots of plants treated with the acid as well as of those treated with the salt.

A similar experiment was made to learn whether the presence of a cosolvent, Tween 20, affected the absorption and distribution of the morpholine salt of 2,4-DI$^{125}$. The radioactive salt was applied as previously described except that the primary leaves of some of the plants were treated with a water solution of the salt, while others were treated with an aqueous mixture containing an equal amount of the salt and 0.5% of Tween 20.

The adjuvant increased both the concentration and the total amount of the salt found in the main axis of the plants. As a result of this increased rate of absorption and translocation due to Tween 20, the amount of the salt which moved from the leaves to the roots was increased by 71%, an effect of interest in connection with the use of 2,4-D in killing deep-rooted perennial weeds. With respect to distribution, the highest concentration of salt occurred in the terminal bud and the lowest concentration in the roots, irrespective of the presence of the adjuvant.

The effect of several cosolvents and several surface-active substances on the absorption of the radioactive morpholine salt was measured. A stock solution was prepared by dissolving the salt in water to make a concentration of 1 μg/0.1 ml. Aliquots of this solution were then used to make mixtures, each containing the same concentration of the salt and the respective adjuvants, individually. These mixtures, including the water solution of the salt without adjuvant, were then applied to the primary leaves of selected test plants as described. Two-hundredths ml of each solution was used per leaf, making a total of 4 μg per plant when calculated on an acid equivalent basis. Plants that received the nine different treatments were arranged as randomized blocks in a greenhouse with three replications of each treatment, a total of 135 plants being used. In these tests, six of the adjuvants increased significantly the amount of the salt absorbed and translocated to the stems, the most effective being Tween 20 (Table 1).

It should be emphasized that the tested adjuvants increased the rate of absorption and translocation of the salt even though the solutions were applied and confined to uniform areas of leaf surface. In this way the spreading effect of the adjuvants was limited. Effects of these and other adjuvants on the absorption of growth-regulating substances are being studied further in an attempt to learn the nature of their action.

TABLE 1

EFFECT OF COSOLVENTS AND SURFACE-ACTIVE AGENTS* ON THE ABSORPTION AND ACCUMULATION OF 2,4-DI$^{125}$ MORPHOLINE SALT IN BEAN STEMS WHEN TREATMENTS WERE CONFINED TO A SURFACE AREA OF 0.5 CM$^2$ ON EACH LEAF (APPLICATION 4 μg PER PLANT; ABSORPTION PERIOD, 72 HR)

| Treatment | Concentration of adjuvant (%) | 2,4-DI$^{125}$ in stems† (mμg) | Increase due to adjuvant (%) |
|---|---|---|---|
| Treated control (salt in water) | | 177 | |
| Tween 20 | 0.5 | 796‡ | 350 |
| Carbowax 1500 | 0.5 | 687‡ | 288 |
| Emulphor-ELA | 0.5 | 544‡ | 207 |
| Repcolene | 0.1 | 534‡ | 202 |
| Igepal-300 | 0.1 | 464‡ | 162 |
| Dreft | 0.1 | 271‡ | 53 |
| Nekal-NS | 0.1 | 202 | 14 |
| BRIJ-30 | 0.1 | 183 | 3 |

* Tween 20 and BRIJ-30 furnished by Atlas Powder Co., Wilmington, Del.; Emulphor, Nekal, and Igepal by General Dyestuffs Inc., N. Y.; Repcolene, by Refined Products Corp., Lyndhurst, N. J.

† Sample composed of first internode and terminal buds.

‡ Significantly greater (by 1:19 or better) than amount detected in control treated without use of adjuvants.

When calculated on the basis of absolute amounts in earlier experiments, radioactive 2-iodo-3-nitrobenzoic acid accumulated in greatest quantities in the terminal buds of bean plants following its application to the leaves (*4*, *6*). This is in contrast to the behavior of both the acid and the morpholine salt of 2,4-DI$^{125}$ which, on the basis of absolute amounts, accumulated mainly in the first internodes and upper part of the hypocotyls. R. W. Holley has reported by personal communication that the distribution of radioactive 2,4-D applied to the leaves in bean plants was similar to that reported here for 2,4-DI$^{125}$.

The growth regulator of the benzoic acid type (2-iodo-3-nitrobenzoic acid) apparently reacted with some constituents in the relatively immature tissues of the terminal bud more readily than with those in the more mature parts of the stem. In contrast, the phenoxy compounds, especially the acid, reacted most readily with constituents of the relatively mature stem tissues.

## References


1. HOLLEY, R. W., BOYLE, F. P., and HAND, D. B. Unpublished manuscript.
2. LINDER, P. J., MITCHELL, J. W., and WOOD, J. W. *Science*, 1950, **111**, 518.
3. MAHLER, H. R., SPEER, R. J., and ROBERTS, A. *Science*, 1949, **110**, 562.
4. MITCHELL, J. W. and LINDER, P. J. *Methods used in tracing radioactive growth regulating substances in plants.* Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Dep't Agr. mimeograph, 1949.
5. MITCHELL, J. W. *et al.* *Science*, 1947, **106**, 395.
6. WOLFE, W. C. *et al.* *J. org. Chem.*, 1949, **14**, 900.
7. WOOD, J. W., MITCHELL, J. W., and IRVING, G. W., JR. *Science*, 1947, **105**, 337.

# Effect of Bacterial Polysaccharide on Cell Division[1]

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In 1943, Shear and his associates at the National Cancer Institute were able to extract, from the red pigmented bacterium *Serratia marcescens*, a polysaccharide which caused regression of tumors in mice and rats (*13*). This important discovery was followed by attempts to use the polysaccharide on human patients, but unfortunately it is more toxic for men than it is for mice (*9*). Accordingly, various workers have attempted to reduce the toxicity in one way or another (*11, 12*).

If progress is to be made, it might be helpful if we knew something about the action of the polysaccharide. In work done a year ago, we showed that heparin could prevent cell division in the egg of the worm *Chaetopterus* (*8*, compare also *3*). This fact was brought into relation to the theory advanced by one of us 20 years ago (*6*). According to this theory, initiation of mitosis is due to a protoplasmic clotting or gelation essentially similar to blood clotting. In all cells that have been investigated, the appearance of the mitotic spindle is preceded by a mitotic gelation. Heparin in dilute solution prevents this mitotic gelation and thus inhibits the division of the cell. In our paper we suggested that the bacterial polysaccharide of Shear might have an effect similar to that of heparin. If this were true, we would then have an explanation of the action of the polysaccharide.

It is logical to assume that the bacterial polysaccharide would act like heparin, for heparin is indeed a polysaccharide. Accordingly, we asked Dr. Shear for some of his bacterial polysaccharide and he was kind enough to supply us with enough for experimentation. Shear's polysaccharide resembles heparin in containing sulfur, although the amount of sulfur is much less than that contained in ordinary heparin compounds (*5*). Moreover, solutions of the bacterial polysaccharide give a beautiful metachromatic (red) color when tested with solutions of toluidine blue. This is a standard test for heparin, and although not conclusive, it gives strong indication of the presence of heparin or heparinlike substances. Also, the bacterial polysaccharide acts like heparin in preventing coagulation of the blood. In experiments with human blood plasma, Sylvia Most[3] found that the bacterial polysaccharide in high enough concentration can completely inhibit clotting. Actually, it is a much weaker anticoagulant than ordinary heparin; thus, for example, the potent heparin preparations of Hynson, Westcott, and Dunning are about 300 times as powerful as the bacterial polysaccharide.

[1] Supported by a grant from the U. S. Public Health Service.

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[3] Mrs. Most's work on the anticlotting activity of the bacterial polysaccharide will be published shortly.

In our experiments with heparin on *Chaetopterus* eggs (*8*), we had some difficulty in obtaining satisfactory results because heparin penetrates the eggs slowly. It is necessary to expose the eggs to heparin solutions for about 10 min before fertilization in order to insure an effect after fertilization. But if they are thus exposed, fertilization is ordinarily inhibited by heparin. We were able to overcome this difficulty by using excess amounts of sperm; with such excess sperm, a high percentage of the heparinized eggs could indeed be fertilized.

The bacterial polysaccharide seems to enter the *Chaetopterus* egg cells more rapidly than does heparin. Accordingly, we were able to introduce the eggs into solutions of the bacterial polysaccharide after fertilization and get a pronounced effect. In four experiments in which eggs were put into a 0.15% solution of bacterial polysaccharide (Shear's PP25 preparation) 2 min after fertilization, the percentage of cleavage varied from 0% to 5%, although control eggs in sea water showed almost 100% cleavage. The counts were made soon after the normal time of cleavage; some hours later a slightly higher percentage of cleavage could be noted in the treated cells. In four other experiments in which eggs were put into dilute solutions of bacterial polysaccharide (0.058%–0.125%) and 5 min later were fertilized with excess sperm, there were three instances in which none of the eggs cleaved at the regular time, and in the fourth instance only 1% of the eggs cleaved. In these experiments in which eggs were exposed to polysaccharide before fertilization, approximately 100% of the eggs were fertilized by excess sperm in three out of four instances; in the fourth experiment 57% of the eggs were fertilized. Similarly, Harding was able to show that bacterial polysaccharide tends to suppress the initiation of mitosis in frog eggs (*4*).

Thus, it is clear that bacterial polysaccharide acts like heparin in preventing cell division. Also, the two polysaccharides have a similar inhibiting effect on fertilization; this inhibition can in both cases be overridden by excess amounts of sperm. Moreover, the bacterial polysaccharide acts like heparin in preventing mitotic gelation. Protoplasmic viscosity tests were made at frequent intervals after the eggs were introduced into solutions of the bacterial polysaccharide. In all instances it could be shown clearly that the protoplasm of the treated eggs preserved its fluidity. Normally, prior to the appearance of the mitotic spindle, the viscosity of the protoplasm rises from a value of 7 to a value of 14 (*7*). In the eggs immersed in the bacterial polysaccharide solutions, the viscosity stays at about 7 during all the time that the control eggs are showing mitotic gelation.

We thus have a simple and clear interpretation of why it is that bacterial polysaccharide prevents cell division, an interpretation perfectly in line with earlier theory. It is our belief that in living cells there is antagonism between thrombin or thrombinlike substances which tends to induce protoplasmic clotting and anticlotting substances, including those of a heparinlike nature.

We believe that heparins and heparinlike substances of cells differ widely in their molecular size and in their

chemical composition. Perhaps those of smaller molecular size or those with less acidity, and consequently with fewer polar molecules, enter cells more rapidly. If a search could be made for all sorts of polysaccharides from many diverse types of cells, we might be able to find one which would cure not only mice but men.

Years ago, Goerner, basing his experiments on the theory proposed by one of us in 1928 (*2*), was able to show that heparin could destroy the tumor-producing potency of tumor cells *in vitro*. We have tried some experiments on the effect of heparin on rat tumors *in vivo*, but as yet have not had much success. The experiment is complicated by the fact that injection of heparin may produce what physicians call "heparin rebound" (*1*), a state in which the blood becomes more instead of less coagulable.

In line with our theory, there is a possibility that various other substances which prevent blood clotting may prevent cell division and be useful in cancer therapy. Actually, some authors have had success with anticoagulant dyes (*10*, *14*). We ourselves have tried the effect of dicumarol on *Chaetopterus* cells and are planning to try it on cancer tissues. The action of dicumarol on *Chaetopterus* egg cells is very striking but somewhat complicated. We will report on it fully in a paper we expect to publish in *Protoplasma*, where we shall also present details of our work with the bacterial polysaccharide.

### References


1. Barnard, B. D. *Science*, 1948, **107**, 571.
2. Goerner, A. *J. lab. clin. Med.*, 1931, **16**, 369.
3. Harding, D. *Proc. Soc. exp. Biol. Med.*, 1949, **71**, 14.
4. ———. To be published.
5. Hartwell, J. L., Shear, M. J., and Adams, J. R. *J. nat. cancer Inst.*, 1943, **4**, 107.
6. Heilbrunn, L. V. *The Colloid Chemistry of Protoplasm*. Berlin: Borntraeger, 1928.
7. Heilbrunn, L. V. and Wilson, W. L. *Biol. Bull.*, 1948, **95**, 57.
8. ———. *Proc. Soc. exp. Biol. Med.*, 1949, **70**, 179.
9. Holloman, A. L. *Approaches to tumor therapy*. Lancaster, Pa.: Science Press, 1947. P. 273.
10. Riley, J. F. *Cancer Res.*, 1948, **8**, 183.
11. Sack, T. and Seligman, A. M. *J. nat. cancer Inst.*, 1948, **9**, 19.
12. Seligman, A. M. *et al.* *J. nat. cancer Inst.*, 1948, **9**, 13.
13. Shear, M. J. and Turner, F. C. *J. nat. cancer Inst.*, 1943, **4**, 81.
14. Williams, W. L. *Cancer Res.*, 1946, **6**, 344.


## Amino Acids in High and Low Protein Corn[1]


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Improvement in nutritive value of plant sources of food both for human and for animal consumption is a challenge to nutritionists and to plant scientists. Progress in research in this field has already led to the use of strains and varieties of plants having superior nutritive value with respect to certain nutrients.

Since the early work of Hopkins (*6*), a number of investigators have shown that there is a definite relationship between protein content and heredity in maize. In spite of these findings, introduction of hybrid corn has generally resulted in production of corn lower in protein content, emphasis being primarily on improved yield per acre. However, high yields and high protein content may not be entirely incompatible if full consideration is given to soil fertility level and density of stand in plants per acre, as well as to heredity.

Corn protein is not of the highest quality, owing to a deficiency of the amino acids lysine and tryptophan in zein, the protein of corn endosperm. The remainder of corn protein is of relatively good quality with respect to its amino acid pattern. The value of corn high in protein content is questionable since much of the increased protein may be in the form of zein, which is characteristically deficient in lysine and tryptophan. Increase in protein content, therefore, may not improve the amino acid pattern, and may even make the total corn protein more unbalanced with respect to the distribution of amino acids.

Doty and associates (*3*) published data which they interpreted as indicating that amino acid distribution in corn protein is heritable. Furthermore, they stated that the physicochemical nature of protein in the grain from two single cross hybrids was distinctly different, as shown by the fact that the sample which contained larger amounts of cystine, arginine, histidine, tryptophan, and tyrosine also contained a larger percentage of alkali-soluble nitrogen and a smaller percentage of alcohol-soluble nitrogen, i.e., the zein fraction.

It follows directly from the heritability of protein that the amounts of amino acids in corn are related to genetic constitution, but it is another question whether or not the amino acid distribution in high protein corn is any different from that in corn of low protein content.

Frey *et al.* (*4*) recently reported on the effects of selection upon protein quality in the corn kernel. In their experiments no improvement was made in the zein-protein ratio in one cycle of selection. These authors stated that the percentage of tryptophan is slightly and positively correlated with the percentage of total protein.

In experiments dealing with the heritability of various nutritive factors in corn, we studied the lysine, tryptophan, and methionine contents of nine different single crosses of inbred lines of yellow dent corn. Individual replicates of these varied in crude protein content from 8.48% to 14.12%.

Each single cross was planted at the same rate in plots two hills wide and ten hills long, each plot being replicated four times in a randomized block. Thus, seasonal, soil, and fertility conditions were uniform, being subjected only to such variation as was imposed by the plot location.

[1] Authorized for publication as paper No. 1563 in the Journal series of the Pennsylvania Agricultural Experiment Station.

[2] From Eastern States Farmers' Exchange, Buffalo, New York.

Amino acids present in the corn kernels were determined by microbiological assay (*3*). Average crude protein and amino acid values for the four replicates of each single cross are given in Table 1.

TABLE 1

AVERAGE CRUDE PROTEIN AND AMINO ACID CONTENT OF CORN

| Single cross | Crude protein % | Lysine % | Methionine % | Tryptophan % |
|---|---|---|---|---|
| NY3 × D59 ..... | 13.02 | .37 | .18 | .13 |
| NY3 × MS19 ..... | 12.55 | .35 | .18 | .11 |
| NY3 × A206 ..... | 11.72 | .34 | .17 | .11 |
| D59 × R51 ..... | 11.20 | .35 | .18 | .09 |
| MS19 × 51A ..... | 11.00 | .31 | .16 | .09 |
| A206 × R51 ..... | 10.13 | .30 | .14 | .09 |
| D50 × 51A ..... | 9.80 | .31 | .15 | .09 |
| R51 × B8 ..... | 8.98 | .28 | .11 | .08 |
| D50 × B8 ..... | 8.95 | .28 | .11 | .08 |
| Standard deviation (individual replicates) | 0.70 | .024 | .015 | .008 |

These data show that the amounts of each of the amino acids studied varied directly with the crude protein content. Highly significant positive correlations for amino acid content and crude protein were obtained as follows: tryptophan, .87; lysine, .85; and methionine, .83. Thus, approximately 70% of the variation in amino acid content may be attributed to regression on protein. The data indicate the same distribution of the amino acids under consideration, in both low and high protein corn.

In view of these results, and since Doty *et al.* included tryptophan in their studies, the correlation for tryptophan and protein was computed from their data. With late yellow single crosses and with miscellaneous single crosses, highly significant positive correlations of .42 and .59 were obtained, but with midseason single crosses the positive correlation of .15 was not significant. These correlations are of a lower order than those already given, and account for much less of the variation in tryptophan values as being due to regression on protein. These results could be interpreted as indicating a change in tryptophan distribution in relation to total protein content. However, the high correlations which we obtained are positive evidence that the amino acid content in these crosses varied directly with the protein.

In our study, most of the variation in amino acid content is accounted for by regression on protein. The only other known sources of variation would be those attributed to plot differences and to experimental error involved in amino acid assay and crude protein estimation. A certain amount of variation or error from these sources is inevitable, leaving very little to be accounted for by changes in amino acid distribution. Thus, results indicate that amino acid distribution of the three amino acids studied is approximately the same for high and low protein single crosses, and that the quality of the protein was not changed with increases in the amount of protein within the range from 8.48% to 14.12%. These findings are in keeping with the viewpoint expressed by Gortner (*5*) that a given organism reproduces the same structural configuration in those proteins which characterize that organism. But there is no positive assurance that the same relationships hold with corn of protein content above 14.12%. In the authors' opinion, however, little economic significance can be given to the production of corn with protein content much above 14%–15%.

Recently, Dobbins *et al.* (*1*) reported experiments with rats and with pigs fed rations in which the same fractional amounts of the total protein were supplied either by low or by high protein corn, the remainder of the dietary protein being provided from other supplementary sources. Under the conditions of these experiments it is apparent that there was little if any difference in the value of the protein from either high or low protein corn.

It might be expected, however, that high protein corn would be especially valuable for ruminants, since the pattern of the dietary amino acids required by these animals is less exacting than that required by monogastric animals such as swine. However, when rations containing high protein corn are fed to swine, smaller amounts of expensive protein supplements might be needed, especially if the newly discovered animal protein factor is included in the diet.

### References


1. DOBBIN, F. A. *et al.* *J. Amer. Sci.*, 1949, **8**, 617.
2. DOTY, D. M. *et al.* *Cereal Chem.*, 1946, **23**, 199.
3. FLACH, W. R. Unpublished data, Eastern States Farmers' Exchange, Buffalo, N. Y., 1949.
4. FREY, KENNETH, J., BRIMHALL, B., and SPRAGUE, G. F. *Agron. J.*, 1949, **41**, 399.
5. GORTNER, W. and GORTNER, R. A., JR. *Outlines of Biochemistry.* New York: Wiley, 1949.
6. HOPKINS, C. G. *Ill. agric. exp. Sta. Bull.*, 1899, **55**, 205.

# Comments and Communications

## Role of the Earth Sciences in General Education

I cannot agree with Eric M. Rogers, in his discussion of science courses for general education in college (*Science*, 1949, 110, 599), that the needs of our future citizens for science education will be fulfilled by courses which only make "students understand what science is like and what scientists are like." This is much too limited a goal for the times in which we live and the long range developments that present events portend.

It is agreed that we should be concerned for the good name of science and that a more general understanding of science is necessary. This is a task that science itself must accomplish by making it possible for the average nonscientist to relate the realities of science to the realities of his own life.

Most of our potential voters in the United States will not attend college, and the majority of the remainder will be nonscientists. It is manifestly impossible to give a general background in all science to the nonscience majors in either high school or college. If it be granted, for the sake of this discussion, that a general science course is the most appropriate one for most of these students, its content should be determined by the objectives of the course. In general, these objectives would seem to be to meet the scientific requirements for democratic citizenship in our present technical age.

Before defining these goals more specifically, let us look at the world in which the students will live. The applications of chemistry, physics, and engineering have supplied the stimulus for our fabulously complex and delicately balanced industrial structure. The biologist and the medical scientist have lengthened life and made it more comfortable. Applications of the biological sciences have given us new crops with higher yields and greater resistance to disease, new strains of animals which produce more pounds of meat or milk per bushel of feed, new compounds and new products which arise daily.

Yet the chemist, the physicist, and the engineer use raw materials which for the most part come from the earth's crust, where they have been produced by geological processes. Organic raw materials depend on the soil and the rain for their abundance. We live almost entirely on the surface of the earth, in buildings composed of materials which have their genesis primarily or secondarily in or on the earth, and which are heated with earth materials.

Thus, everywhere our students turn, the basic factors in their daily lives are those which compose the physical environment. These are the weather, the climate, the terrain, the soil, the water, the biological and mineral resources. These factors, plus geographical location, have much to do with national strength and prosperity.

The United States is an industrial country. The fruits of the physical environment, and their proper use, have great influence on the health of industry, and thus on our national well-being. Only careful use, and adequate renewal when possible, will maintain our resources at an effective level. Only an informed and scientific approach to the use of the physical environment will make this possible.

In a democracy such as ours, if we expect to preserve it, the voter must therefore understand how his environment operates. He must also have a basis for understanding the role these elements play in national survival. And he should be able to comprehend the basic principles utilized in effective exploitation of the physical environment to buttress and maintain our standard of living.

Until rather recently the United States was a frontier nation. Our thinking has been geared to a constantly expanding economy. Now we have occupied all of our readily utilized area, yet our population is increasing rapidly. We are constrained, by the very nature of our national mores, to maintain a high standard of living, which in turn requires a stable economy. To do this we must use what we have with ever-increasing efficiency.

Outside our boundaries, present international trends suggest that the United States may eventually become the only effective island of democracy in a political sea of communism. In this event, the strain on our economic system will be great, since the spread of communism will eliminate a large part of our foreign trade. In any event, we face the possibility of a long period of ideological and economic stress, during which we must be increasingly self-sufficient. This is not to mention that as long as communism maintains its present attitude, the threat of war will always loom just over the horizon.

Under these circumstances, if we must restrict most of our potential voters to a single year of general science (for high school graduates) plus an additional year for most of those fortunate enough to go to college, which is more important? To give our students a liking for science? To give them a scientific basis for citizenship in the disturbed and confusing world of this mid-century? Or less modestly, to strive to give them a scientific foundation for both? I submit that the latter is the only reasonable long range goal for general science education.

In order to demonstrate better the need for such a goal, let us look at some of the national problems with which our voters and our legislators must be concerned if we expect to maintain our national vigor and an economy characterized by free private enterprise. Among them are:

1. Our national use of the land.
2. The distribution of production (which in the last analysis is dependent on raw resources).
3. The preservation and use of timber resources, and reforestation.
4. Effective utilization of our national regions of differing climate and productivity as one homogeneous national unit.
5. The water problem: control of rivers and drainage systems to prevent floods, produce usable power, and as-

sure maximum productivity of drainage areas; measures to cope with the depletion of underground water, which is now becoming of national concern.

6. More effective and more stable use of such areas as the Great Plains.

7. The soil problem: prevention of erosion and depletion; renewal of areas that have been partially exhausted and more effective use of marginal lands.

8. The problem of mineral resources: more accurate information concerning supply and demand; utilization of "marginal" deposits; a realistic national policy concerning importation of scarce raw materials to prevent peacetime exhaustion of domestic deposits which may be essential during war.

Furthermore, the nature and distribution of the world's natural resources and arable lands and their political control will have an important effect on the future of our internal national economy.

Now if our high schools and colleges were to offer students a general science course designed to meet the goal stated above, it could provide them with an understanding not only of the basic principles of science, but also of the ways in which these principles operate to produce and modify the physical environment with which we must live in harmony. The sciences which deal with the physical environment (geology, geography, meteorology, etc.) rest on the application of the fundamental laws and practices of other sciences (chemistry, physics, biology, etc.) to the problems of the earth and its biota. A general science course could as well demonstrate the workings and applications of the laws of gases through a consideration of weather as through a standard laboratory experiment in physics or chemistry. The principle of the indestructibility of matter is as well explained through the processes of weathering of rocks and the production of soil as through an experiment in chemistry. The reasoning and methods utilized in a problem in local weather forecasting, or the development of terrain, illustrate how scientists think and work as effectively as an example from the history of science.

Thus in addition to an understanding of scientific principles, the knowledge gained in such a course would show the influence of geophysical factors on the development of industry, the history of settlement and the constantly changing tides of international relations. Even more basically, it would illustrate cogently the impact of these factors on the life of the student himself and the world in which he lives, and be far better remembered for this reason. From the cultural standpoint, geology and related subjects also seem to offer one of the best vehicles for an understanding of the long sweep of human activity which leads us back to the caves of Asia Minor during the glacial period. For despite our "conquest" of our environment, the climate, the resources, and the geography of the land across which our race has moved have had much to do with where we have gone and how we have traveled. It would seem extremely difficult to understand human history, therefore, without some comprehension of the framework within which it occurs.

Lest I be accused of special pleading, let me quote the views of a distinguished scholar, the dean of Yale College, William Clyde DeVane (*Yale Review*, Autumn 1943, pp. 34–46). In discussing the high school curriculum, he wrote

> . . . the pupil should be introduced, but in no easy way, to the concepts of the natural sciences which shape so much of our thinking. A sound course in physics on one side or in biology will do this admirably, but I should recommend a course in geology, which seems to me to have peculiar advantages for boys at this age. In content, it is concerned both with inorganic nature and with life in nature. Its tremendous sweep in time gives perspective. It is an incomparable study for giving the young imaginative mind the largest conceptions of space and time, and at the same time it inculcates scientific methods and principles.

In his further discussion of an optimum general education program at the college level, Dean DeVane continued

> . . . it [the curriculum] must be as adequate for our day as the Greek and mediaeval syntheses were for their times. It must show the student the inanimate world and give him a grasp of the principles upon which it exists; it must present the panorama of history, of man's ideas and institutions, of his struggles, failures, and successes.

In view of the fact that the physical environment is the canvas on which man has painted the panorama of his history, it seems reasonable that the general science course as outlined here would meet Dr. DeVane's requirements. Furthermore, it would contain no "blocks" and no "gaps"; rather, it would be a complete and integrated fabric. The warp would be the science of the surrounding environment, which has always influenced and will always modify man's activities; the woof would be the demonstrated laws and processes that cause the environment to operate and change. From this synthesis the student could come to understand how his environment works, and that our collective interaction with it produces certain effects which must be met by cooperation with nature. The principles of scientific thought and investigation then become an integral part of the subject matter, and are brought recurrently to the attention of the student by every change in the weather, the sight of a new or strange terrain, or an item in the daily newspaper.

Moreover, as the work week has shortened, many more persons have leisure to travel, to seek recreation in the out-of-doors, and to visit our state and national parks. Surely the cultural value of some knowledge of the origin of scenery and an understanding of the reasons why the various regions of our country demonstrate such different features and development should not be ignored in the preparation of an educated citizen.

Except for the unfortunate pattern of science teacher preparation and a certain amount of academic timidity, there is no reason why such courses cannot be offered at varying levels of complexity, to students ranging from junior high school to college. The institution or the department that has the courage to discard traditionalism and approach general science education in this way may find it difficult, but infinitely rewarding. The students who are so fortunate as to be enrolled in such a course will receive a stimulating insight now granted to few, and a firm basis for better living and more understanding citizenship.

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## Compounds Capable of Plant Amylase Inhibition

It has been reported (*Science*, 1950, **111**, 118) that 2,4-dichlorophenoxyacetic acid inhibits the alpha and beta amylase activity in the stems and leaves of the red kidney bean plant. In this connection it seems pertinent to call attention to our little-known report (Volker, J. F., and Murray, D. P. Salivary amylase inhibition. *Tufts Dental Outlook*, 1947, **21** [2], 3) in which we were able to demonstrate that indole nucleus containing plant hormones, including indole acetic acid, indole butyric acid, and indole propionic acid, were effective anti-amylases when added to refined starch in concentrations as low as 0.01%. Comparable anti-amylytic ability was also shown for similar concentrations of 2,4-dichlorophenoxyacetic acid, triiodobenzoic acid, naphthalene acetic acid, naphthoxyacetic acid, and nicotinic acid.

In view of these observations, it is suggested that in addition to 2,4-dichlorophenoxyacetic acid other of the above-mentioned compounds may be capable of plant amylase inhibition.

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## Discovery of Early Cretaceous Mammals and Frogs in Texas

Following a suggestion by Glen L. Evans, of the Texas Memorial Museum, the Early Cretaceous Trinity Sands of Montague County, Texas, were briefly investigated for turtle remains early in November. While fragments of an interesting turtle were being collected, the most fortunate discovery of a lower jaw of a triconodont mammal was made. On a return visit, a few days later, a second and more complete jaw of the same form was secured. Mesozoic mammals are among the rarest and most interesting of vertebrate fossils. These triconodonts are the first mammals discovered in the Early Cretaceous of the New World. The only other known mammalian remains of this age are five isolated teeth from a locality in southern England. Until now, triconodonts were known only from the Jurassic and the latest Triassic.

The triconodonts are associated with fragmentary remains of land, fresh water, marine, and aerial forms. Crocodiles, dinosaurs (carnosaurs and ornithopods), pterosaurs, turtles, frogs, and fish are represented. The vertebrate fauna occurs here in marly sands that probably were deposited in the intertidal zone of a transgressing Early Cretaceous sea. The facies is in general similar to that of the mammal-bearing beds of the German Rhaetic and of the English Stonesfield Slate.

The discovery of frogs in these Trinity Sands may well prove to be of the utmost significance, since no members of this order have hitherto been reported from the Cretaceous period. In view of the fact that frog remains are known from Jurassic and even older deposits, the present finds may help to fill a conspicuous gap in our knowledge of the history of the order.

Since only a few days were spent in the region, there is every reason to hope that the new triconodont will become better known when intensive collecting is undertaken and that perhaps other mammals, more significant in the early history of the living orders, may be discovered. Work on a much more extensive scale is being planned by the Chicago Natural History Museum in northeastern Texas, in cooperation with E. H. Sellards, director, and Glen L. Evans, assistant director, of the Texas Memorial Museum.

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*Chicago Natural History Museum*

## Arctic Ice Drift and the Humboldt Current

Exception must be taken to the article by Lalla R. Boone, "A Prediction Regarding the Humboldt Current" (*Science*, 1949, **110**, 642), insofar as data collected by the International Ice Patrol are used by the author in attempting to show a relationship between "ice outbreaks in the Arctic" and abnormalities in the Humboldt Current three years later. The North Atlantic ice seasons of 1922 and 1938 are cited as having been unusually heavy and associated with the 1925 and 1941 failures of the Humboldt Current. The area kept under surveillance by the International Ice Patrol during the ice season is in the vicinity of the Grand Banks of Newfoundland and for purposes of comparing different years, the number of bergs reaching positions south of the 48th parallel has been estimated for each year. The berg counts for each year from and including 1900 are shown graphically in an article entitled "Arctic Ice and Its Drift Into the North Atlantic Ocean." The 9th edition of this article was published as a supplement to the May, 1949, *Pilot Chart of the North Atlantic* and the article is published as such a supplement each spring. The average for the 50-year period 1900–1949 is about 430 bergs per year. The numbers for the years 1922 and 1938 were 523 and 664 respectively and therefore greater than average. There seems no reason why these two years should be singled out when many other years also have had about the same or a larger number of bergs, as for instance the following:

| Year | Berg Count | Year | Berg Count |
|---|---|---|---|
| 1903 | 802 | 1929 | 1,351 |
| 1905 | 845 | 1932 | 514 |
| 1907 | 638 | 1934 | 560 |
| 1909 | 1,024 | 1935 | 875 |
| 1912 | 1,019 | 1939 | 850 |
| 1913 | 550 | 1943 | 840 |
| 1914 | 731 | 1944 | 700 |
| 1921 | 746 | 1945 | 1,083 |
| 1928 | 515 | 1948 | 523 |

The years 1922 and 1938 are described as being characterized by unusual outbreaks of arctic ice in the North Atlantic, presumably from reports of the International Ice Patrol on conditions in the region of the Grand Banks. This region is the terminus for the comparatively few

bergs which survive the journey of possibly two and probably three years. Therefore, if one may presume that the number of bergs completing this journey is related to the number beginning it, any unusual number of bergs calved from their parent glaciers in 1922 and 1938 would be reflected by unusual berg counts south of 48° in 1924 or 1925 and 1940 or 1941 respectively. The berg counts for these years were:

| Year | Berg Count | Year | Berg Count |
|---|---|---|---|
| 1924 | 11 | 1940 | 2 |
| 1925 | 109 | 1941 | 2 |

There are, however, many variable factors combining to produce the more than 90 percent mortality which the bergs suffer during their two- or three- year journey from Greenland to the Grand Banks and these factors have yet to be evaluated quantitatively. Fluctuations in these factors may or may not leave valid the presumption that a large number of bergs calved in any one year will be reflected as a large berg count south of the 48th parallel two or three years later. If it is valid and if the author proposes to gauge the size of the crop of northern bergs produced in 1949 by the number which appear in the Grand Banks region, the success or failure of the prediction made will not be known until 1951 or 1952; but if the author means that an outbreak of ice was due in the Grand Banks region in 1949, then the prediction has already failed, since only 47 bergs are estimated to have crossed the 48th parallel in 1949.

FLOYD M. SOULE

*International Ice Patrol*
*U. S. Coast Guard, Woods Hole, Massachusetts*

## Reaction Time of the Common Housefly (*Musca domestica*)

During the course of unrelated ballistic experimentation, the opportunity presented itself to observe the reaction time and rate of wing stroke of the common housefly by means of high speed cinematography. The fly was walking near the edge of a flexibly supported plate of bullet-resistant material approximately 6 in. square. A bullet fired at the center of the plate approximately 3 in. from the fly caused the flexibly supported plate to be jerked away from the fly's feet with great rapidity, leaving the fly suspended in the air.

Analysis of the high speed motion picture record (about 2,400 frames per sec) revealed that the fly remained suspended in the air for a short time. It was then caught in what appeared to be a downdraft and commenced to fall, without showing any sign of wing activity. It had fallen perhaps ¼ in. before it began to beat its wings. This occurred 21 msec after its support had been jerked away. About 1 msec before the first wing motion, it appeared to extend its rear legs to the utmost, as though attempting to spring from the nonexistent support. Although camera focus was not good enough to reveal fine detail, the fly appeared to execute this motion three times at intervals of slightly more than 1 msec. These motions may represent a stereotyped pattern of launching, carried out without realization that the support was no longer in position (Fraenkel, G. *Z. vergl. Physiol.*, 1932, **16**, 371).

Shortly after (about 0.01 sec later) the plate rebounded and nudged the fly, turning it upside down. Despite this, and despite the apparently strong air currents buffeting it (caused by the violent movement of the plate), the fly continued to beat its wings strongly. It finally righted itself accidentally by colliding with the support and flew out of view of the camera. Its wing beat frequency through these vicissitudes continued approximately constant, as far as could be determined, at about 212 strokes per sec.

Unfortunately no record had been kept of the room temperature, but this is believed to have been in the neighborhood of 75° F.

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[1] The author wishes to express thanks to Captain Charles W. Tillett, III, for making the record available for analysis; and to Dr. Leigh Chadwick for initiation into some phases of the literature concerning *Musca domestica*.

## I. Q. and Month of Birth

In a recent article (*Science*, 1949, **110**, 267) C. A. Mills claims impressive advantages for children conceived during the cold months of the year. He says, "In any field of accomplishment one investigates, the advantages of cold-weather conception stand forth in bold relief."

We have some experience in the Philadelphia public schools that tends to give mild support to this statement. Children admitted to school in September consistently have slightly higher average scores on both aptitude and achievement tests than do children admitted to school in February. Pupils admitted in September generally are those who were conceived during the months of September through March. Children admitted in February are those conceived during the months of April through August.

As was true of E. Huntingdon's studies (*Season of Birth*, New York: Wiley, 1938; and *J. genet. Psychol.*, 1944, **64**, 323), there are factors other than the season of birth that tend to explain why children in the classes admitted in September have higher average scores in tests than children in classes admitted in February. For example, the number of pupils admitted in September is larger than the number admited in February because such admissions represent a seven-month crop of births in contrast with the five-month crop in February. The larger wave of enrollment in the September classes tends to be equalized with the smaller wave in the February classes because of retardation and failure. More pupils fail from the September classes into the February classes than fail from the February classes into the September classes. The result is that the September classes normally have a smaller proportion of low I. Q.'s than the February classes.

In order to analyze further the possible effect of cold weather on conception a part of Pintner's study (Pintner,

TABLE 1

PINTNER DEVIATION INTELLIGENCE QUOTIENTS—GRADE 7A, OCTOBER 1948*

| Pintner deviation I. Q. | Month of birth | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | |
| 140–149 | 2 | 0 | 1 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 3 | 0 | 17 |
| 130–139 | 9 | 5 | 9 | 12 | 13 | 12 | 9 | 14 | 17 | 14 | 18 | 13 | 145 |
| 120–129 | 36 | 27 | 30 | 20 | 55 | 53 | 59 | 62 | 47 | 40 | 48 | 27 | 504 |
| 110–119 | 74 | 39 | 70 | 76 | 84 | 100 | 123 | 121 | 120 | 93 | 79 | 56 | 1035 |
| 100–109 | 107 | 104 | 100 | 131 | 141 | 156 | 156 | 177 | 178 | 144 | 153 | 109 | 1656 |
| 90–99 | 145 | 116 | 153 | 121 | 172 | 166 | 187 | 213 | 160 | 171 | 162 | 149 | 1915 |
| 80–89 | 138 | 115 | 130 | 123 | 109 | 148 | 167 | 123 | 140 | 133 | 102 | 124 | 1552 |
| 70–79 | 81 | 53 | 80 | 54 | 77 | 84 | 76 | 80 | 86 | 70 | 79 | 76 | 896 |
| 60–69 | 30 | 15 | 33 | 27 | 28 | 18 | 21 | 27 | 22 | 20 | 22 | 21 | 284 |
| 50–59 | 10 | 9 | 9 | 13 | 8 | 13 | 5 | 5 | 6 | 13 | 5 | 9 | 105 |
| Total | 632 | 483 | 615 | 578 | 689 | 752 | 804 | 825 | 777 | 699 | 671 | 584 | 8109 |
| Median | 93.9 | 94.3 | 93.6 | 96.0 | 97.1 | 96.8 | 97.1 | 98.3 | 98.4 | 96.6 | 97.9 | 94.2 | 96.4 |

* Representative sampling of pupils in New York City, Philadelphia, Pittsburgh, Cleveland, and Detroit.

R. and Forlano, G. *J. educ. Psychol.*, 1933, **24**, 561) was repeated.

Dates of birth and Pintner Deviation I. Q.'s were available for over 8,000 children chosen as a randomized sample of the beginning grade 7 population in public schools in October, 1948, in New York City, Philadelphia, Cleveland, Pittsburgh, and Detroit. A distribution of these I. Q.'s by month of birth is shown in Table 1.

The month with the highest median is September. The lowest median is for March, the difference amounting to 4.8 points which is statistically reliable, being 7.5 times the probable error of the difference. With two minor exceptions there are I. Q.'s at all levels for all months. Pintner found a difference of 2.25 I. Q. points between September and February averages.

On account of the selective factor just explained that would place in the September classes smaller proportions of low I. Q. individuals, a second study was undertaken by the authors. In this case the records of an entire school were studied for the I. Q.'s of children born in April and October. I. Q.'s were available for the Philadelphia Verbal Ability Test. The distributions are reported in Table 2.

TABLE 2

PHILADELPHIA VERBAL ABILITY INTELLIGENCE QUOTIENTS APRIL AND OCTOBER BIRTHS*

| P.V.A. I. Q. | April births | October births |
|---|---|---|
| 135–150 | 1 | 1 |
| 127–134 | 5 | 6 |
| 119–126 | 12 | 23 |
| 111–118 | 29 | 42 |
| 103–110 | 48 | 59 |
| 95–102 | 59 | 55 |
| 87–94 | 36 | 37 |
| 79–86 | 10 | 15 |
| 70–78 | 3 | 1 |
| Total | 203 | 239 |
| Median | 102.1 | 104.6 |

* Dobbins Vocational-Technical School, Philadelphia, November 1949.

Here again there is a difference in favor of the births in the fall (October births, January conceptions). The difference, while it amounts to 2.5 I. Q. points, is of questionable reliability, being only 2.6 times the probable error of the difference.

There is nothing in the data reported above that denies a slight I. Q. advantage for cold-weather conceptions. On the other hand, there is nothing that would warrant long vacations for the country's obstetricians for the first half of each year.

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# Book Reviews

***Adaptation and Origin in the Plant World: The Role of Environment in Evolution.*** Frederic E. Clements, Emmett V. Martin, and Frances L. Long. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1950. 332 pp. $6.00.

The senior author of this publication, the late F. E. Clements, is well known for his writings in the field of plant ecology. He has been one of the pioneers in this branch of botany in the United States and his publications, along with those of another pioneer, the late H. C. Cowles, have done much to formulate and clarify our ideas of plant succession. The textbook, *Plant Ecology*, with which Clements shared authorship with J. E. Weaver, was for many years the standard text for introductory courses in this subject.

Dr. Clements was a field botanist. Observing plants in the field under varying external conditions, he was perhaps unduly impressed by the role of environment in molding organisms and finally came to believe that new forms could arise by the action of environmental factors alone. The present volume represents the results of controlled experiments conducted in the field, over a period of some 40 years, which were intended to determine the role of environment in evolution. The preface, by Edith S. Clements, states that the results of these studies, conducted by Dr. Clements and his co-workers, were originally planned to be published in a series of four booklets. The first book in this series (E. V. Martin and F. E. Clements), was published in 1939. The second booklet is an account of adaptation under control in many garden habitats at Santa Barbara, including the Dune Gardens. The third volume was to have dealt with response to climatic and edaphic conditions in numerous natural gardens of the transplant transect on Pikes Peak. The fourth and final book of the series was intended to be a detailed analysis and discussion of the convergence and conversion of species at both centers and of the ecological basis of evolution. The original plan was somewhat modified after Dr. Clements' retirement, when it was decided to combine booklets II and III into one volume. This manuscript was practically completed before the death of both Dr. Clements and Dr. Long in 1945. The present volume consists of most of that material, in addition to some of the information originally intended for book IV.

The publication is copiously illustrated by excellent photographs and there are numerous tables and graphs. With the current interest in experimental taxonomy, many will find these data of particular interest, although the authors' interpretations may be open to question.

It has long been known that organisms show different responses to varying environmental conditions. The authors of this volume conclude that adaptation is brought about by responses to direct physical factors and is expressed both in function and in form. They further state that for all the species employed, there is no evidence that it arises through the selection of genetic strains or variations. They believe that it is possible to convert one Linnaean species into another by altering the environment. Further, that while "the conversion of one genus into another, morphologically at least, is much more difficult than with species, it is far from impossible." One might wonder whether these supposed species and genera are able to hybridize, and the answer is provided in the publication. Crossing was employed in a number of species, chiefly with reference to its *supposed* value in distinguishing between species and forms of lesser rank. The result was that "crosses between groups with the character of Linnaean species have failed in all cases tried." It seems incredible that environment is able to convert one species into another when these plants are so unrelated that they are unable to exchange genes. If species *A* and *B* are not able to hybridize and through environmental changes *A* is converted to *B*, we should expect that a cross between the new *A* and *B* would be successful. This reviewer has failed to find in the publication any evidence that such an experiment was attempted. A rather strange statement is that "Perhaps hydridization is to be regarded primarily as a nutritional (chemical) rather than a genetic disturbance directly."

In contrast to these conclusions are those of Clausen, Keck, and Heisey (*Carnegie Instn. Wash. Publ.*, 1940, 520), who conducted similar experiments. Dr. Clausen is an able geneticist, and Dr. Keck is a taxonomist of sound reputation. These authors conclude that natural selection determines the character of the plants that occupy a given environment, and that the ability of a plant to accommodate itself to a new environment is dependent upon its genetic constitution. They further state that, in their studies, changes produced by the environment give no evidence of permanence, and although they may be quite spectacular, they never obscure the individuality of the plant.

The present volume is no exception to other publications by Dr. Clements in regard to specialized terminology. Fortunately, there is a glossary, without which many might have found difficulty in following the discussions.

JOHN R. REEDER

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***Phenomena, Atoms and Molecules.*** Irving Langmuir. New York: Philosophical Library, 1950. 436 pp. $10.00.

This collection of papers by Irving Langmuir might well be dedicated to the spirit of W. R. Whitney, who to such a large extent was responsible for the development of basic research in an industrial laboratory.

Of the 18 papers, three deal with general principles of science, its development, and scientific philosophy. The fourth, "Surface Chemistry," is the lecture given by Langmuir at the time he received the Nobel prize,

and is a classic not only from the point of view of content but also because of the clarity with which the subjects are presented. The seventh paper, "Atomic Hydrogen as an Aid to Industrial Research," is far more than the title promises, and gives an insight into the psychology of discovery and the importance of basic research in industry.

A large number of the essays are devoted to the arrangement of molecules, their distribution and orientation, and the connection between the structure of liquids and surface tension, the phase of Langmuir's work that is so famous. There are also his investigations on atomic hydrogen and the question of chemical forces, valency, and structure.

One wishes that every student of physics or chemistry could study these papers carefully, and it is regrettable that the price of the volume is so high. If a reprint of the first four essays and the seventh could be published as a small pocket book it could be used with profit by students of science and science education. There is a complete bibliography with more than 200 titles, offering an amazing outline of the various activities of the author in a large number of fields of physics and chemistry.

KARL LARK-HOROVITZ

*Purdue University*

***The Sea and Its Mysteries: An Introduction to the Science of the Sea.*** John S. Colman. London: G. Bell and Sons; New York: British Book Centre, 1950. 285 pp. 12s. 6d. net.

This very readable book covering the broader aspects of oceanography is a welcome addition to the literature, particularly for those wishing a general picture of marine life, of waves and currents, and of the chemistry of sea water. The illustrations are clear and well chosen. There is a delightful account of the Great Barrier Reef of Australia, which will appeal to scientist and layman alike.

The authoritative chapters on "Animal Plankton" and "Life in the Depths" are very interesting reading. Only minor criticisms can be offered. Some people may object to the overemphasis of the Atlantic and the inadequate treatment of the Pacific. The chapter on "The Shape of the Sea" is comparatively accurate but disappointingly short; it gives very little of the recent American investigations. The "Short List of Reading Matter on the Sea" at the end of the book could have been somewhat lengthened to supply the needs of readers who develop a wide interest in oceanography.

Understandable errors regarding the character of tsunamis (tidal waves) may be found in the book. These waves are erroneously attributed to earthquakes rather than to the movements that cause or accompany the earthquakes, and the "much faster" movement of tsunamis than wind waves in shallow water is erroneous, as many of us who experienced these waves in Hawaii can testify. The continental slope is said to have a "ruling gradient between 1 in 17 and 1 in 30," but a world-wide study indicates that the average is 1 in 14. One imagines that Colman's figures came largely from the Atlantic, although even there greater average declivities are found. One of the best features of the book is the clear indication throughout that the author knows the sea from firsthand experience. This is particularly apparent in the last chapter, with its stimulating account of many of the natural phenomena likely to be encountered on a sea voyage.

FRANCIS P. SHEPARD

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***Plant Pathology.*** Sir Edwin J. Butler and S. G. Jones. London-New York: Macmillan, 1949. 979 pp. $10.00.

The first part of this book, on "General Principles," includes discussions on the structure, growth, life histories, dissemination, and variation in fungi; host-parasite relationships; influence of environment on disease; resistance and susceptibility; virus diseases; and deficiency diseases. Most of these topics are presented thoroughly, yet clearly and simply. The discussions appear to be based on extensive firsthand knowledge of a large number of fungi and diseases, as well as critical evaluation of world-wide literature on the subjects. Chapter 2, which includes discussions on persistence of parasites from year to year, heteroecism, specialization of parasitism, saltation, nutritional stimulation of parasites, and epidemics, is perhaps rather weak. Significant literature published in some of these fields in the last 20 years is not cited (only 35 references are cited for the entire chapter, permitting only sketchy coverage of most subjects). Some of the basic and practical principles established in plant pathology as a result of researches in these fields during the last 20 years are not mentioned.

The section on principles is followed by a nine-page synopsis of the classification of fungi that admirably summarizes the distinguishing characteristics of classes, subclasses, and principal orders and families of fungi. Under each family the genera most important in plant pathology are listed.

Section 2 includes summaries of selected diseases of the major groups of crop plants—cereals, forage and pasture crops, potatoes and root crops, pulses (peas and beans), vegetables, fruits, ornamentals, and forest and shade trees. Under each crop there are one or more examples of diseases caused by the major groups of organisms known to be of pathologic importance on that host. The general types of diseases to which the major crop plants throughout the world are subject are well covered. Discussions of the individual diseases are clear, thorough, and well documented by literature citations both to specific research papers and general reviews.

There are 435 illustrations, most of them excellent, some of them outstanding. Many are original; few have ever appeared previously in any text. Most of the specific diseases discussed have good illustrations of symptoms, the fungus, and pathologic histology.

Literature citations follow each discussion of general principles and each individual disease or crop. The citations are arranged alphabetically, an advantage for the reader. However, only in a very few instances are titles or page numbers of papers cited; thus the reader cannot

distinguish between a 200-word abstract and a 200-page monograph. In a book such as this, that will probably be used as a text and reference in advanced classes, literature citations are an essential part of the authors' contribution. The cryptic style of literature citation used here is frustrating to the student who wishes to go back to original sources.

In general, the book is a very competent presentation of the principles of plant pathology and of representative diseases of the world's chief crop plants. It should prove useful to beginning and advanced students in many countries.

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# *Scientific Book Register*

***The Hormones: Chemistry, Physiology and Applications,*** Vol. II. Gregory Pincus and Kenneth V. Thimann, Eds. New York: Academic Press, 1950. 782 pp. $12.50.

***Anatomy of the Dicotyledons: Leaves, Stem, and Wood in Relation to Taxonomy,*** 2 vols. C. R. Metcalfe and L. Chalk. New York: Oxford Univ. Press, 1950. 1500 pp. $25.00.

***Manual of Standardized Procedures for Spectrophotometric Chemistry.*** Harold J. Fister. New York: Standard Scientific Supply Corp., 1950. 500 pp. $30.00.

***The Merck Manual of Diagnosis and Therapy.*** 8th ed. Rahway, N. J.: Merck & Co., 1950. 1592 pp. $4.50; thumb-index edition $5.00.

***Nuclear Physics: A Textbook.*** Francis Bitter. Cambridge, Mass.: Addison-Wesley, 1950. 200 pp. $5.50.

***L'Expansion de L'Univers.*** Paul Couderc. Paris: Presses Universitaires de France, 1950. 222 pp. 500 fr.

***Methods in Climatology.*** 2nd ed. V. Conrad and L. W. Pollak. Cambridge, Mass.: Harvard Univ. Press, 1950. 459 pp. $7.50.

***The Anatomy of Mathematics.*** R. B. Kershner and L. R. Wilcox. New York: Ronald Press, 1950. 416 pp. $6.00.

***Economic Mineral Deposits.*** 2nd ed. Alan M. Bateman. London: Chapman & Hall; New York: John Wiley, 1950. 916 pp. $7.50.

***Molecular Spectra and Molecular Structure: Spectra of Diatomic Molecules,*** I. 2nd ed. Gerhard Herzberg. New York: D. Van Nostrand, 1950. 658 pp.

***An Introduction to Plant Physiology.*** Otis F. Curtis and Daniel G. Clark. New York: McGraw-Hill, 1950. 752 pp. $6.50.

***Studies in Social Psychology in World War II: Measurement and Prediction,*** Vol. IV. Samuel A. Stouffer *et al.* Princeton, N. J.: Princeton Univ. Press, 1950. 756 pp. $10.00.

***Plant Viruses and Virus Diseases.*** 3rd rev. ed. F. C. Bawden. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1950. 335 pp. $6.00.

***Oral and Facial Cancer.*** Bernard G. Sarnat and Isaac Schour. Chicago: Year Book Publishers, 1950. 300 pp. $6.00.

***Birds of the West.*** Ernest Sheldon Booth. Stanford, Calif.: Stanford Univ. Press, 1950. 402 pp. $6.00.

***Atlas of Human Anatomy: Splanchnology, Angeiology, Nervous System, Organs of Sense,*** Vol. II. M. W. Woerdeman. Philadelphia: Blakiston, 1950. 642 plates, index. $10.00.

***Social Psychology: An Integrative Interpretation.*** S. Stansfeld Sargent. New York: Ronald Press, 1950. 519 pp. $4.50.

***Principles of Ionic Organic Reactions.*** Elliot R. Alexander. New York: John Wiley; London: Chapman & Hall, 1950. 318 pp. $5.50.

***Hydrogen in Chemical Atoms: Analysis of Spectral Levels from Li I to O VII.*** William Mayo Venable. Pittsburgh, Pa.: Markowitz, Haas & Kopelman, 1950. 156 pp. $4.00.

***Practical Invertebrate Anatomy.*** W. S. Bullough. London-New York: Macmillan, 1950. 463 pp. $4.50.

***Hydrology: The Fundamental Basis of Hydraulic Engineering.*** 2nd ed. Daniel W. Mead. New York-London: McGraw-Hill, 1950. 728 pp. $7.50.

***Differential Algebra.*** Joseph Fels Ritt. New York: American Mathematical Society, 1950. 184 pp. $4.40.

***The Nutritional Improvement of Life.*** Henry C. Sherman. New York: Columbia Univ. Press, 1950. 270 pp. $3.75.

***The Scientist's Ready Reckoner: Logarithmic Tables for All Those Engaged in Physical and Biological Sciences.*** W. Roman. The Hague, Holland: Dr. W. Junk; London, England: Wm. Dawson & Sons, 1950. 142 pp. 15/–.

***German Science Reader: An Analytical Approach to Translation Problems.*** George Wm. Radimersky. New York: Ronald Press, 1950. 245 pp. $3.00.

***Petroleum and Its Products.*** 24th annual Priestley Lectures. William J. Sweeney. State College, Pa.: Dept. of Chemistry, Pennsylvania State College, 1950. 5 chapters. $2.25.

***The Physiology of Work and Play: A Textbook in Muscular Activity.*** Sarah R. Riedman. New York: Dryden Press. 584 pp. $4.90.

***Practical Television Engineering.*** Scott Helt. New York Murray Hill Books, 1950. 708 pp. $7.50.

***Textbook of Healthful Living.*** 4th ed. Harold S. Diehl. New York: McGraw-Hill, 1950. 776 pp. $4.00.

***General Chemistry.*** 2nd ed. John Arrend Timm. New York: McGraw-Hill, 1950. 764 pp. $4.50.

# News and Notes

## Symposium on Nuclear Reactions in Light Elements

E. Bleuler and R. Steffen

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Continuing a series of sessions on special fields of physics started last year, the Physics Division of the Oak Ridge National Laboratories arranged on June 8 and 9 a meeting on nuclear reactions in light elements. It was attended by approximately 150 guests, representing for the most part university and other research laboratories. The chief topic of the meeting was the study of energy levels and cross sections.

Accurate determinations of reaction energies were reported by W. W. Buechner (MIT). A large magnet with central core is used to deflect the reaction products emitted at 90° to the incident beam. Utilizing 180° focusing, the momentum spectrum is recorded with the aid of photographic plates. With careful corrections for angular spread, absorption in the target and in surface layers, energy values can be determined to an accuracy of about 1 kev. Results were given for the (d,p) reactions on $B^{10}$ and $B^{11}$. In the latter instance the levels of the residual nucleus seem to be arranged in successive groups of 1, 2, 3, and 4, with increasing excitation energy. The α groups from $B^{10}$ (p, α) $Be^7$ show only the well-known excited state of $Be^7$ at 430 kev. Transitions to the questionable states at 250 and 750 kev are less probable by a factor of at least a thousand. The $N^{14}$ (d,p) $N^{15}$ reaction reveals a number of doublets in $N^{15}$. Exact measurements of $Q$-values of 24 additional reactions were also reported.

The investigation of the interaction of tritons with protons and tritons was discussed by A. Hemmendinger (Los Alamos). The threshold of the (p,n) reaction on a Zr + T target was determined to 1019 ± 1 kev, yielding a neutron-hydrogen mass difference of 782 ± 2 kev, assuming zero neutrino mass. The cross section increases with increasing proton energy, indicating the presence of a resonance level above 2.5 mev. The same result is obtained from the gamma ray yield of the capture reaction. The excited level of $He^4$ involved is placed at about 21.6 mev above the ground state. No intermediate levels need be assumed, since coincidence absorption measurements show only one gamma ray of about 20 mev. The angular distribution indicates contributions to the reactions from $^1P$ and $^2P$ states of the excited $He^4$ nucleus. Preliminary results were presented suggesting that T + T reactions may lead to the formation of a short-lived $He^6$ nucleus or to the emission of a di-neutron.

The determination of position, width, and density of excited levels with the aid of fast monoenergetic neutrons was reported by H. H. Barschall (Wisconsin). Angular momenta are assigned on the basis of the interference between potential and resonance scattering and by calculating the reduced width of the resonances. This method has had outstanding results. The neutron scattering resonance of $He^4$ at about 1.2 mev is shown not to be a doublet but to correspond to a $P_{3/2}$ level only. Various nuclei in the region of $A = 20$ to $A = 40$ have level spacings of the order of 100 kev. The closing of a neutron shell in $Ca^{40}$ seems to have no influence on the level density. The remarkable difference between $Bi^{209}$ (no resonances) and $Pb^{208}$, $Pb^{206}$ (with distinct resonance patterns) is not yet explained fully.

The fourth talk, given by T. W. Bonner (Rice Institute) dealt with the measurement of negative $Q$-values of (d,n)-reactions by observation of thresholds for neutron groups. Since the neutrons are emitted, near threshold, with comparatively low energy, they are detected with good efficiency by a BF, counter surrounded with a small amount of moderating material which is not sufficient for the slowing down of the high energy neutrons emitted to the lower levels. Using thin targets, a sharp rise of the neutron intensity is observed at the threshold permitting the determination of $Q$-values with an accuracy of a few kev and also an estimate of the level width.

The sessions of the second day were opened with a paper on the cross sections of thermonuclear reactions presented by W. A. Fowler (Caltech). Two reaction cycles converting hydrogen into helium have been proposed as energy sources in stars, the well-known carbon-nitrogen cycle and the $H(p,\beta^+)D(p,\gamma)He^3(p,\beta^+)He^4$ cycle. In order to evaluate the relative importance of the two mechanisms, the cross sections of the individual reactions must be known. Because of the thermal velocity distribution and the increase of cross section with energy, a rather well-defined band of energy, 10 to 30 kev for the different reactions, gives the largest contribution to the reaction rate. Since a direct measurement of the cross sections at these energies is impossible, the procedure adopted is to extrapolate the cross sections from resonances at higher energies by means of the dispersion formula. Direct measurements around 100 kev, performed with the aid of a high intensity proton beam, give reasonable agreement with the calculated values. In this way the reactions $D(p,\gamma)He^3$ for the H-He cycle and $C^{12}(p,\gamma)N^{13}$, $N^{14}(p,\gamma)O^{15}$, $N^{15}(p,\alpha)C^{12}$ for the C-N cycle were investigated. In the latter instance the second reaction was shown to be the slowest, leading to a half-life of $2.5 \cdot 10^5$ years for $N^{14}$. In the light particle cycle the reaction rate is determined by the first process $H(p,\beta^+)D$ for which only a theoretical estimate of the cross section is available. It appears that the light particle processes are the major source of energy for not too hot stars, and probably also for the sun.

In the last scheduled paper R. F. Christy (Caltech) made several remarks about the theoretical interpretation of experimental data. He pointed out that the reduced level width may vary by as much as a factor of

a 100 between different levels, making the assignment of angular momenta by this method uncertain. He recommended, as a more direct procedure, the study of angular distribution of gamma rays or particles emitted in reactions. The most interesting of different levels investigated is that of 480 kev in $Li^7$, for which a spin of 5/2 has been postulated. The angular correlation between the alpha particles and the gamma rays of the reaction $B^{10}(n, \alpha\ \gamma)Li^7$ shows, however, spherical symmetry, suggesting $J = 1/2$ fór the excited state, though compatible with a special choice of higher angular momenta. The resonance scattering and absorption of protons lends itself to an analysis similar to that of neutrons, as exemplified by investigations on Be and Li.

The afternoon session was devoted to short contributed items and general discussion. The various topics included a preliminary measurement of an additional level in $Li^7$ at 850 kev, the use of NaI single crystals for scintillation spectrometers, especially for gamma rays, a circuit for magnetic resonance measurements, angular distribution of the deuterons and alpha particles from Be + p and of the alpha particles from $Li^7$ + p, a discussion of apparent subthreshold neutrons in (p,n)-reactions and a study of (d,n)-reactions indicating in some cases stripping of the deuteron at 15 mev rather than formation of a compound nucleus. Measurements of the $Q$- value of $Li^7$ (d, p) $Li^8$ by detecting the recoil nucleus and of the resonances of $P^{31}(p, \gamma)S^{32}$ were reported. Allen (Chalk River) described an investigation of the T + T reaction similar to that carried out at Los Alamos. He finds, at the low bombarding energy of 200 kev, that the probability of the emission of a di-neutron is smaller than $10^{-3}$. An apparent peak in the $He^4$ recoil distribution indicating the formation of a di-neutron is found to be caused by deuteron contamination of the beam or the target.

A dinner in the evening and an informal outing to the Smoky Mountains on the following day closed this successful meeting.

## About People

**Edward A. Doisy,** biochemist at the St. Louis University School of Medicine, has been appointed to the Atomic Energy Commission Advisory Committee for Biology and Medicine. He replaces **A. Baird Hastings,** of Harvard University.

**Robert B. Lewy,** clinical assistant professor of otolaryngology at the University of Illinois College of Medicine, will present a paper entitled "A Clinical and Anatomical Evaluation of the Sphenoid Palatine Ganglion" at the International Anatomical Congress at Oxford, England, July 24–28. While in England, Dr. Lewy plans to make a survey on advanced graduate education in otolaryngology at the United Oxford Hospital.

**L. C. Knorr,** associate plant pathologist at the Citrus Experiment Station, University of Florida, will be on leave to the Florida State Plant Board for a year to conduct investigations in Argentina on the control of tristeza, a virus disease affecting citrus fruits. His address after August 1 will be Estación Experimental, Concordia, Entre Ríos, Argentina.

**Sidney W. Benson,** associate professor of chemistry, University of Southern California, has been awarded a scholarship for work at the University of Paris under the terms of the Fulbright Act. Dr. Benson is also the recipient of a Guggenheim fellowship for the academic year. He plans to write a book on chemical kinetics during his stay in Europe.

**Harold Friese Plank,** research assistant in the Chemistry Department, Massachusetts Institute of Technology, and **Marshall Nicholas Rosenbluth,** Department of Physics, Stanford University, have been appointed to the staff of the Atomic Energy Commission's Los Alamos Scientific Laboratory.

**Edward Abrams,** head of the Biology Division of the Institute of Textile Technology, Charlottesville, Virginia, has been appointed head of the Textile Section of the Southern Research Institute. Under his direction the institute plans immediate inauguration of an expanded and diversified service program to the textile industry.

**Walter C. Bucher,** professor in the Department of Geology, Columbia University, has been elected executive officer of the department for a three-year period. Dr. Bucher succeeds **Paul F. Kerr,** who will now serve as research coordinator. **Marshall Kay** was elected educational coordinator.

**William G. Myers,** research associate professor in the Departments of Physiology and Medicine, Ohio State University, and his wife, **Florence R. Lenahan,** instructor in medicine at the university, will spend two months this summer visiting European research laboratories that use radioactive isotopes for research. Dr. Myers and Dr. Lenahan will accompany **Paul Aebersold,** chief of the Isotopes Division of the Atomic Energy Commission, Oak Ridge, Tennessee.

**Rolston L. Bond,** technical director of the Butadiene Division of Cities Service Refining Corporation, Lake Charles, Louisiana, has been named assistant chairman of the Chemistry and Chemical Engineering Department at Armour Research Foundation, Illinois Institute of Technology. Dr. Bond will be in charge of the foundation's biochemistry and organic chemistry research activities.

## Visitors to U. S.

Recent visitors at the National Bureau of Standards were **Donald F. McRae,** director, Department of Industrial Research Services, Ontario Research Foundation, Toronto; **Hans Pinardi,** director, Departamento Ciencias Puras, Universidad Nacional, Mendoza, Argentina; **Kwanzi Suda,** chief hydrographer, Hydrographic Bureau, Maritime Safety Agency, Japan; **Toshio Sudo,** assistant professor, Geological Institute, University of Tokyo, Japan; **A. C. van Dorsten,** research

physicist, Philips Research Laboratories, Eindhoven, Holland; **N. A. Whiffen**, technical secretary, Council for Scientific and Industrial Research, Commonwealth of Australia, Melbourne; **A. H. Gillieson**, head of the Emission Spectroscopy Group, and **A. A. Smales**, head of the Analytical Chemistry Group, Atomic Energy Research Establishment, Harwell, England.

**Min Din**, of Kamayuta, Rangoon, is currently studying microfossils, particularly the Cushman collection of Foraminifera, at the U. S. National Museum.

## Grants and Awards

**The Commonwealth Fund** has awarded 20 fellowships for 1950–51, including the following for research in science: *Alan Rushton Battersby*, lecturer in chemistry, University of St. Andrews—to study structural problems in organic chemistry at the Rockefeller Institute for Medical Research, New York City; *Mary Bradburn*, senior lecturer in mathematics and dean, Royal Holloway College, London—to study mathematical physics at Radcliffe College; *Douglas Hames Millen*, lecturer in chemistry, University College, London—to study the techniques of microwave spectroscopy and the electrochemistry of strong acids at the Massachusetts General Hospital and Harvard University; *Donald Vernon Osborne*, research student at Cambridge—to investigate the properties of liquid helium II, at the Institute for the Study of Metals, University of Chicago; *John Donaldson Ross*, tuberculosis physician, Bangour Hospital Area, West Lothian, Scotland—to study epidemiological research methods as applied to tuberculosis at the Johns Hopkins University and the Henry Phipps Institute, University of Pennsylvania; *Derrick Rowley*, premedical student at St. Mary's Hospital Medical School, London—to study immunochemistry at the College of Physicians and Surgeons, Columbia University; *Astor Balfour Sclare*, medical registrar to the Psychiatric Unit, Killearn Hospital, Stirlingshire—to study psychosomatic medicine at the College of Medicine, University of Cincinnati; *Ian Ferguson Sommerville*, research assistant, Department of Biochemistry, University of Edinburgh—to study the physiological aspects of the metabolism of steroids at the Sloan-Kettering Institute for Cancer Research, New York City; *Frank Sidney Stone*, assistant lecturer in chemistry, University of Bristol—to study experimental techniques in photochemistry at Princeton University; *John Frederick Thomson*, assistant in philosophy, University College, London—to study mathematical logic at Harvard and Princeton Universities; *Barry Maurice Waller Trapnell*, holder of research award at the Davy Faraday Laboratory, Royal Institution, London—to study heterogeneous catalysis and magneto chemistry at Northwestern University; *Andrew Hugh Wallace*, assistant, Department of Mathematics, University College, Dundee—to study algebraic theories at the University of Chicago; *Ronald Karslake Starr Wood*, lecturer in plant pathology, Imperial College, London—to study plant pathology and nutrition at the College of Agriculture, University of California, Berkeley; *Andre Cyril Myburgh*, entomologist, Western Province Fruit Research Station, Department of Agriculture, Union of South Africa—to study the control of pests affecting deciduous fruits, at Cornell University, the U. S. Bureau of Entomology, and other centers.

The Netherlands Society for Refrigeration has conferred the **Kamerlingh Onnes Medal** upon F. E. Simon, Oxford, England, in recognition of his contributions to refrigeration techniques at very low temperatures. The presentation will take place in Leyden on September 21, the birthday of the late H. Kamerlingh Onnes.

**The American Association of University Women** presented its annual achievement award of $2,500 to Elizabeth C. Crosby on June 21. Dr. Crosby is professor of anatomy at the University of Michigan Medical School, and plans to use the award for the purchase of equipment for her research.

A grant of $10,000 has been awarded to John G. Gibson 2nd, of Harvard Medical School, by the **National Institutes of Health, Public Health Service**. The grant will enable Dr. Gibson to continue his studies on the fundamental problems of the preservation of blood, which he has conducted in collaboration with Edwin J. Cohn, Higgins University Professor of Harvard, and other associates. Dr. Gibson is research associate at Harvard Medical School.

## Colleges and Universities

**The University of Rochester** has made a number of appointments to its Physics Department to enlarge its teaching program and to increase cosmic ray investigation, theoretical physics, and research with the university's two cyclotrons. New appointments are: Arthur Roberts, State University of Iowa, associate professor of physics; Harry W. Fulbright, Princeton University, assistant professor; John H. Tinlot, Columbia University, assistant professor; Richard Wilson, Clarendon Laboratory, Oxford, England, and David M. Ritson, Dublin Institute for Advanced Studies, Ireland, both research associates. Visiting research associates for the summer are C. H. Yang and Kenneth M. Case, both of the Institute for Advanced Study, Princeton, New Jersey.

**Brown University's third symposium on plasticity** will be held September 8–9 under the auspices of the university's Graduate Division of Applied Mathematics. Papers will be presented by both foreign and American experts in the field on stress-strain relations and problems and methods in the analysis of structures and continuous media. Further information may be obtained from D. C. Drucker, Associate Professor of Engineering, Brown University, Providence 12, Rhode Island.

**Cornell University** has established a center for integrated aerial photography to train scientists to use this technique for surveys in various fields and, through research, to ex-

tend its use to new areas. Donald J. Belcher is director of the center. The program includes technical work in the College of Engineering, in the fields of optics, geodesy, cartography, photogrammetry, instrumentation, and aeronautics. The Departments of Agronomy and Conservation and Soils in the College of Agriculture and the Department of Geology assist in air photo interpretation problems. The Department of Land Economics and the College of Architecture participate in land planning.

## Meetings and Elections

**The Illuminating Engineering Society** will hold its national technical conference in Pasadena, California, August 21–24. Arrangements have been made for a special train leaving Chicago August 18, that will stop over one day at the Grand Canyon. Registration fees are $18 for society members and $9 for members of their families. Further information and advance registration forms may be obtained from Illuminating Engineering Society, 51 Madison Avenue, New York City.

**The National Shade Tree Conference** will hold its annual meeting August 21–25 in Syracuse, New York, with headquarters at Hotel Syracuse. Among those presenting papers will be Curtis May, U. S. Department of Agriculture, Paul J. Kramer, Duke University, and J. C. Carter, Illinois Natural History Survey. The program will include a number of plant clinics, exhibits of products for tree care by commercial companies, and field demonstrations at the New York College of Forestry, in collaboration with Cornell University. Those wishing to attend should write to L. C. Chadwick, Secretary, National Shade Tree Conference, Department of Horticulture, Ohio State University, Columbus.

**A conference of biological societies** will be held at Ohio State University September 11–14, under the sponsorship of the American Institute of Biological Sciences. Member societies assisting in the plans for the meeting are the American Society for Horticultural Science, the American Society of Plant Physiologists, the Botanical Society of America, the Ecological Society of America, the Genetics Society of America, and the Mycological Society of America. Additional groups participating in the program include the American Bryological Society, the American Society for Human Genetics, the American Society of Limnology and Oceanography, the American Society of Naturalists, the American Society of Plant Taxonomists, the Phycological Society of America, the Society for the Study of Evolution, and the Society of Industrial Microbiologists. An attendance of 2,500 biologists is expected. A biological sciences exhibit, to be held at the museum of the Ohio State Archaeological and Historical Society, will be a feature of the program. Further information may be obtained from Dr. C. H. Hylander, Carnegie Institution of Washington, 1530 P Street, N.W., Washington, D. C.

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**A new laboratory for medical research using radioisotopes** has been opened at the National Institutes of Health, Bethesda, Maryland. Much of the construction and equipment of the five chemistry laboratories comprising the facility is experimental, and allows the addition or replacement of equipment as new materials and techniques are developed. The laboratory will afford maximum facilities for experimentation and maximum protection against radiation hazards. A "radiation safety group" of five scientists trained in handling radioactive substances will monitor operations, to permit correction of abnormal conditions before there is danger to the staff, and also before the validity of experiments is affected.

**The CARE-Unesco Book Fund Program** in the Pakistan and India area was launched in June by the contribution of 53 volumes on farming and engineering to the University of Sind, in Karachi, and 80 technical books to Punjab University at Lahore. Educational institutions in India, Ceylon, Burma, and Jordan soon will receive gifts. Approximately $160,000 worth of books already have been delivered to more than 250 foreign institutions under the program, which now reaches 20 countries.

Universities, research laboratories, and other institutions and individuals who may have important new scientific movies appropriate for showing in the **Science Theatre** at the AAAS Annual Meeting in Cleveland, Ohio, December 26–30, are invited to write at once to the AAAS Science Theatre, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

## Recently Received

***A Bibliography of the Herpetology of Japan.*** Carl Gans. Vol. 93, Art. 6, American Museum of Natural History, NYC. $1.25.

***Proceedings and Papers, 17th Annual Conference, California Mosquito Control Association, and Annual Conference, American Mosquito Control Association.*** California Mosquito Control Association, P. O. Box 649, Berkeley 1, Calif.

***Development of a Test for Selecting Research Personnel.*** American Institute for Research, Pittsburgh, Pa.

***Rational Exploitation of the Sea Fisheries with Particular Reference to the Fish Stock of the North Sea.*** Special Scientific Report: Fisheries No. 13. G. P. Baerends. Translated by Jan Hahn. U. S. Department of Interior, Washington, D. C.

***The Zoology of Iceland.*** Vol. II, Part 20a. *Oligochaeta 1. Lumbricidae,* Helge O. Backlung. Vol. IV, Part 59. *Amphineura.* Jorgen Knudsen. Part 62. *Scaphopoda.* Jorgen Knudsen. Part 63. *Marine Bivalvia.* F. Jensenius Madsen. Part 72. *Marine Pisces.* Bjarni Saemundsson. Ejnar Munkgaard, Copenhagen, Denmark, and Reykjavik, Iceland.

***Biochemical Aspects of Genetics.*** Biochemical Society Symposia No. 4. Cambridge University Press, 51 Madison Avenue, New York City. $1.50.

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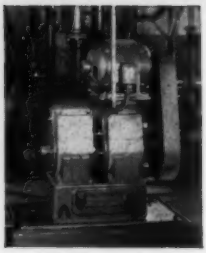

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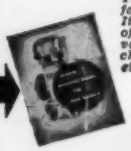

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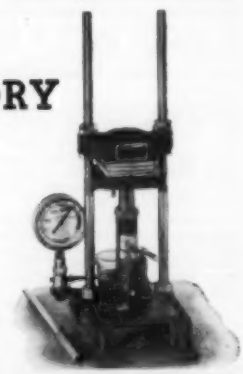


Designed to facilitate research and development wherever pressing is required. Carver accessories provide 3 means of pressing oil and liquids, splitting of chilled oils, pressing extracts, saps and juices from plant and animal tissues, etc. All thoroughly standardized, available for immediate shipment from stock. Send for new illustrated catalog giving full details.

**FRED S. CARVER INC.**
HYDRAULIC EQUIPMENT
341 HUDSON ST. NEW YORK 14, N. Y.

# Personnel Placement

**CHARGES and REQUIREMENTS for "PERSONNEL PLACEMENT" Ads**

1. Rate: 15¢ per word, minimum charge $3.00 for each insertion. If desired, a "Box Number" will be supplied, so that replies can be directed to SCIENCE for immediate forwarding. Such service counts as 8 words (e.g., a 25-word ad, plus a "Box Number", equals 33 words). All ads will be set in regular, uniform style, without display; the first word, only, in bold face type.

For ***display*** ads, using type larger or of a different style than the uniform settings, enclosed with separate border rules, the rate is $16.00 per inch; no extra charge for "Box Numbers".

2. Advance Payment: All Personnel Placement ads, ***classified*** or ***display***, must be accompanied by correct remittance, made payable to SCIENCE. Insertion can not be made until payment is received.

3. Closing Date: Advertisements must be received by SCIENCE, 1515 Mass. Ave., N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

## POSITIONS WANTED

**Anatomist:** Professor and head, department of anatomy, university medical school, past 12 years; available immediately; for further information, please write Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

**Botanist,** Ph.D., M.S. zoology, young woman, considerable teaching experience including bacteriology, biology. Box 225, SCIENCE. 7/14

**Insect Physiologist:** Ph.D., 28; Ecology, toxicology, morphology. Zoology, biochemistry minors. Teaching, research experience microtechniques. Prefer research position, consider teaching. Veteran. Sigma Xi. Available immediately. Box 229, SCIENCE. X

**Microbiologist,** M.Sc., woman, degree minors—chemistry, soil bacteriology, research experience. Box 228, SCIENCE. 7-28

**Microbiologist:** B.S., M.S., Industrial experience, antibiotics, vitamins, research-development, fermentations, pilot plant, control, assay supervision, mutation induction. Box 230, SCIENCE. X

**Physiologist:** Ph.D.; male, single, 29, methodist, 15 publications, June graduate, 3 years as hospital technician, available immediately. Box 226, SCIENCE. X

**Plant Geneticist,** Ph.D. Plant physiology minor. Desires research or teaching position in physiology, genetics, or agronomy. Box 227, SCIENCE. X

**Zoologist:** Experienced college teacher desires change, research opportunity. Several years successful teaching. Ph.D. Former National Research Council Fellow. Research publications in ecology. Interested in teaching, museum, research, or library position. Box 215, SCIENCE. 7/14

## POSITIONS OPEN

**Positions Open:**
**(a) Biochemist;** Ph.D., clinical laboratory, fairly large voluntary hospital; newly created position; opportunity research, medical school affiliation; $5000–$7000; West. **(b) Technically trained** young man to take over control and responsibilities of making intravenous solutions, sterilizing and testing them for sterility and absence of pyrogens; must be qualified to set up complete standards laboratory; manufacturing company; East. **(c) Young physician** qualified biochemistry to become associated with pathologist, Diplomate and FACP, director of laboratories, large general hospital; new laboratory department now being completed; metropolitan area of East. **(d) Assistant professor of anatomy** to direct course in embryology, assist in histology and neural anatomy; will consider Ph.D. in zoological fields if experienced in teaching histology and embryology. **(e) Chairman of department** of pharmacology, Ph.D.; assistant in physiology, minimum of M.S. degree, trained in neurophysiology and assistant in anatomy; Middle Western college. **(f) Director of Research,** small company, interesting program of expansion; physician with research experience, pharmaceutical industry required; $12,000–$15,000. S7-2 Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

# Personnel Placement

## POSITIONS OPEN

**UNIVERSITY OF DACCA, East Bengal, Pakistan.**

● Applications are invited for the following posts on terms stated against each:

1. **Professor of Physics**—Salary will depend upon qualifications and may amount to Rs. 2000/- p.m. including allowances. In exceptional cases it may be increased to Rs. 2500/-p.m.
2. **Professor of Botany**—Salary will depend upon qualifications and may amount to Rs. 1500/- p.m. including allowances.

N.B. Re. 1/- = 2S 1¾d i.e. £1 = Rs. 9.24)

Appointments will be on deputation or contract not exceeding 5 years or permanent basis in exceptional cases. Benefit of Provident Fund for service not less than five years, contribution to which on either side being 6¼% of the salary. Quarters will be provided on payment of 10% of salary. First class free passage for joining appointment at Dacca will be provided.

Applicants should be distinguished scholars, with experience of University teaching and guiding research. Knowledge of English is essential. Candidates should give full details of age, nationality, academic career, teaching experience, and original publications enclosing a copy of each; also testimonials and names and addresses of three referees.

**Applications must reach the Registrar, University of Dacca (P.O. Ramna), East Bengal, Pakistan not later than 31st August, 1950.**

***P.S. Special attention is invited to the present rate of exchange and the extended date for receiving applications.***

# The Market Place

## BOOKS


**The SHRUNKEN MOON**
**By J. E. SPURR**
207 pages • 36 text figures • Price $4.00
**BUSINESS PRESS • Lancaster, Penna.**

**Your sets and files of scientific journals**
are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. J. S. CANNER AND COMPANY, 909 Boyston Street, Boston 15, Massachusetts. tf

**WANTED — YOUR PERIODICALS**
*We need Complete Sets, Runs, Volumes and Single numbers.*
*CASH IN on your periodical accumulations NOW!*
**COLLEGE LIBRARY SERVICE • Dept. A, Box 311, N. Y. 3**
*Also send us your list of wants*

Send us your Lists of tf
**SCIENTIFIC BOOKS AND PERIODICALS**
which you have for sale.
Complete libraries; sets and runs; and single titles are wanted.
Also please send us your want lists.
**STECHERT-HAFNER, INC., 31 East 10th Street, New York 3.**

# The Market Place

## CHARGES and REQUIREMENTS for "MARKET PLACE" Ads

1. **Rate:** 20¢ per word for *classified* ads, minimum charge $5.00 for each insertion. Such ads are set in uniform style, without display; the first word, only, in bold face type. For *display* ads, using type larger or of a different style than the uniform classified settings, and entirely enclosed with separate rules, rates are as follows:

| | |
|---|---|
| Single insertion | $16.00 per inch |
| 7 times in 1 year | 14.50 per inch |
| 13 times in 1 year | 13.00 per inch |
| 26 times in 1 year | 11.50 per inch |
| 52 times in 1 year | 10.00 per inch |

2. **Payment:** For all *classified* ads, payment in advance is required, before insertion can be made. Such advance remittances should be made payable to SCIENCE, and forwarded with advertising "copy" instructions. For *display* advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

3. **Closing Date:** Classified advertisements must be received by SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

### BOOKS

**WANTED TO PURCHASE:**
**SCIENTIFIC PERIODICALS**
Sets and runs, foreign and domestic
**SCIENTIFIC BOOKS**
Entire libraries and smaller collections
**WALTER J. JOHNSON**
125 East 23rd Street, New York 10, N. Y.

### PROFESSIONAL SERVICES

**RUSSIAN** technical and other articles translated, abstracted, and reviewed accurately, promptly. All fields. Inquire Box 222, SCIENCE. 7/14

### SUPPLIES AND EQUIPMENT

***ANIMAL CAGES AND ACCESSORY EQUIPMENT***
ORDERS NOW ACCEPTED FOR EARLY DELIVERY
**HOELTGE BROS., Inc.**
1919 Gest St. Cincinnati 4, Ohio
*Write for New 1950 Catalog*

**All Amino Acids** (natural, synthetic, unnatural), Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.
**BIOS LABORATORIES, INC.** 17 West 60th Street, New York 23, N. Y.

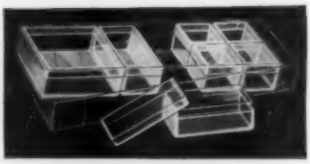
FIALA OUTFITS, INC.
10 WARREN STREET, NEW YORK 7, N.Y.
SCIENTIFIC INSTRUMENTS & FIELD EQUIPMENT
FOR GEOLOGISTS, SURVEYORS, ENGINEERS & EXPLORERS
Every necessity suggested & supplied as proved by experience in the field from Poles to the Equator
INCORPORATED 1925

# The Market Place

### SUPPLIES AND EQUIPMENT

**TRANSPARENT BOXES**

**Maximum protection and visibility for samples, specimens, small parts etc. Five stock sizes. Leaflet S-507 free on request.**



**Pocket Set No. 4-S (transparent case, 10 assorted boxes) for field trips $1. 6 for $5.**

**R. P. CARGILLE**
118 Liberty St., New York 6, N. Y.

**GLYCOCYAMINE—Hydroxyproline, L-Methionine**
• AMINO ACIDS • BIOCHEMICALS
• PRE-MIXED MICROBIOLOGICAL ASSAY MEDIA
**H. M. CHEMICAL COMPANY, LTD.**
144 North Hayworth Avenue Los Angeles 36, California

**QUARTZWARE**
for laboratory and industry
A complete line of standard laboratory ware. Also custom fabricating to meet your requirements.
For particulars, write: *Quartzware Division*
**THE PANRAY CORP.**
340 Canal Street, New York 13, N. Y.

**LABORATORY ANIMALS**
DOGS CATS MICE RATS PIGEONS POULTRY RABBITS HAMSTERS GUINEA PIGS
• Clean healthy well-fed animals • Guaranteed suitable for your needs. Reasonably priced—Dependable service
JOHN C. LANDIS • Hagerstown, Md.

**STAINS**
STARKMAN Biological Laboratory
• RARE • COMMON
*Price list on Request*
• 461 Bloor St., W. Toronto, Canada

**• HYPOPHYSECTOMIZED RATS**
Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc. • 808 E. 58th St. Chicago 37, Ill.

NEW—IMPORTANT **BVL AGAR MEDIA TABLETS**
**SAVE TIME and EXPENSE—AVOID DRUDGERY**
*Simply add water and sterilize*—Nutrient in 10 cc and 50 cc amounts, Sabouraud Dextrose, 'Czapek-Dox, Malt, Malt Dextrose and Various Plant Extract and Digest Media in Lots of 100 and 1000 Tablets and Plain Agar in Lots of 250 and 1000 Tables.
**BEN VENUE LABORATORIES, Inc. • Bedford, Ohio**

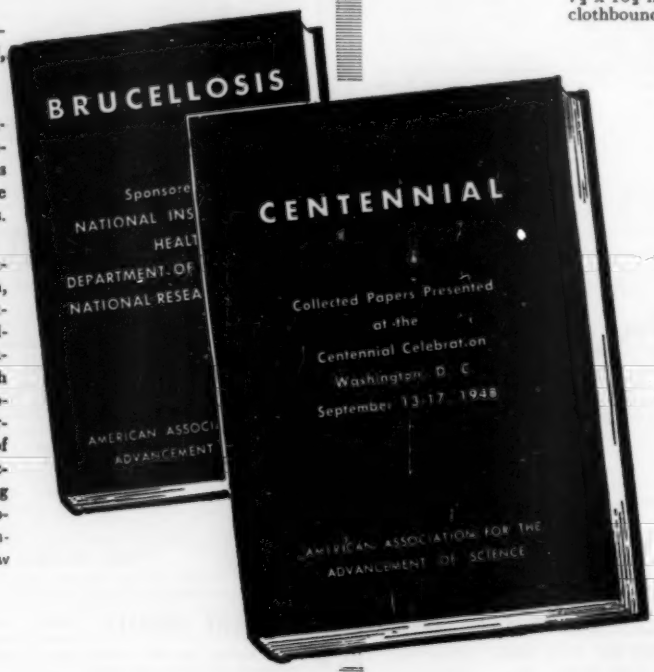
. . . merits the attention of physicians, veterinarians, agricultural scientists, and chemists . . .

# Brucellosis

6 x 9 inches, illustrated, clothbound, 277 pages

This AAAS symposium volume presents in 24 papers a comprehensive view of Brucellosis.

The National Institutes of Health, the U. S. Department of Agriculture, and the National Research Council who cosponsored the verbal presentation of these treatises, succeeded in obtaining as contributors pioneers in this comparatively new field.




**Cash price to AAAS members $3.50**
**Nonmembers and institutions $4.00**

. . . a unique symposium volume that enriches your library with its scientific and historic value . . .

# Centennial

7½ x 10½ inches, double column, clothbound, 320 pages

Symposia presented to commemorate the first hundred years of AAAS include 42 papers by leading scientists in thirteen major fields:

Sciences of Society
Educational Potentials
Human Individuality
Food and Nutrition
Housing
World Health Problems

Sources of Energy
The Upper Atmosphere
The World's Natural Resources
Genes and Cytoplasm
High Polymers
Interactions of Matter and Radiation
Waves and Rhythms

**Cash price to AAAS members $4.50**
**Nonmembers and institutions $5.00**

*Note: Members may use the special prices only for prepaid orders and for one copy of each publication.*

**AAAS, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.**

Enclosed find my check or money order in the amount of $.....
for ..... copies of Brucellosis, ..... copies of Centennial.

**Name** .....

**Address** .....

**City** ..... **Zone** ..... **State** .....

**now**

**you can collect fractions economically**

with this new

# TIME/FLOW

**fraction collector**

FOR routine laboratory fractionation, where the finesse and ultimate-degree precision of the Technicon automatic drop-counting collector exceeds the requirement of the task, this new flow-rate collector is an efficient and economical instrument. Based on a sound rate-of-flow principle, the time-controlled mechanism will automatically collect any number of samples up to 200: any predetermined volume-per-sample up to 25cc.

As each fraction is collected, the carriage automatically advances to repeat identical collections consecutively until the whole fractionation has been made. When speed is essential, a tandem-collector (optional) can be hooked-in to double output. The Technicon Flow-Rate Collector is completely automatic: requires no attention during operation. Set it for the given experiment and go away: it will shut off automatically on completion of the fractionation. Send the coupon below for details.

**SAVES TIME AND LABOR**

completely automatic, it frees laboratory technicians for more productive tasks than fraction-cutting.

**IMPROVES RESOLUTION**

by collecting a larger number of smaller samples, resulting in sharper demarcation.

**TRIPLES WORK OUTPUT**

it will run twenty-four hours a day, as against a standard eight-hour laboratory work day.

# technicon

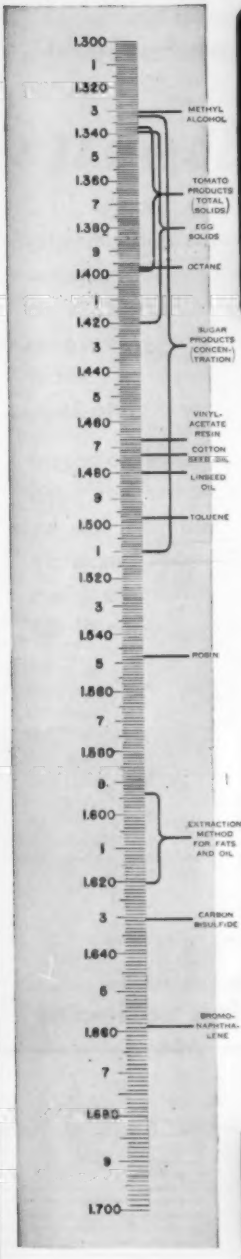
**automatic TIME/FLOW fraction collector**

THE TECHNICON COMPANY
215 East 149 St., New York 51, N. Y.
Please send me particulars of the new Technicon "Flow-Rate" Fraction Collector.

Name.....

Address.....

City.....State.....




# PRECISE PROCESS CONTROL

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Quick, critically accurate determinations of refractive index and dispersion are easily accomplished with Spencer Refractometers. In many industries these determinations are a convenient basis for control of quality. Food, petroleum, chemical, rubber, distilling, pharmaceutical, optical, and many other industries find its use of great value.

One of the six types of Spencer Refractometers may answer a real need in your research or production departments. For additional information write Dept. G2.

American Optical COMPANY

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